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2002 Evaluation of 4VWX Herring

Évaluation des stocks de hareng dans 4VWX en 2002

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Abstract

Fishery, sampling, acoustic surveys and research results were compiled and used to evaluate the status of herring in the NAFO Division 4VWX area.

Landings from the SW Nova Scotia/Bay of Fundy spawning component amounted to 71,570t. Age composition of the catch contained a small fraction of fish older than the 1994 year-class (age 7). Recruiting herring from the 1998 year-class dominated the fishery in 2001 at age 3.

Spawning stock biomass (SSB) in the SW Nova Scotia/Bay of Fundy spawning component was estimated from acoustic surveys of spawning grounds to be about 507,000t. For standard survey areas the SSB was 370,000t representing a decline over the last three years. Larger amounts of spawning fish were documented in Scots Bay and Trinity Ledge but fewer herring were recorded on the German Bank spawning grounds than in recent years. There was evidence of reappearance of spawning on the Seal Island grounds, but this area and Trinity Ledge remained well below historical levels.

The 2001 herring fishery on the Scotian Shelf banks landed 12,500t substantially more than in 2000 and about the same as in 1999. Catches were primarily in May and June in the vicinity of 'The Patch' as well as in the Western Hole/Roseway Bank areas. The July bottom trawl survey, with the last 4 years the highest on record, continued to indicate a general high abundance and widespread distribution of herring on the banks west of Sable Island.

Changes to management and recent research efforts have improved the knowledge of the fishery in four of the coastal Nova Scotia spawning areas, but there remains a problem of a lack of biological and fishery information for much of this component. There is continued concern for the status of the Bras d'Or Lakes spawning herring.

Résumé

Nous avons compilé et utilisé les résultats de pêche, d'échantillonnage, de relevés acoustiques et de recherches pour évaluer l'état du stock de harengs dans les divisions 4VWX de l'OPANO.

Les débarquements de reproducteurs capturés dans le secteur sud-ouest de la Nouvelle-Écosse/baie de Fundy s'élevaient à 71 570 t. Les prises comprenaient une petite fraction de poissons plus vieux que la classe d'âge de 1994 (7 ans). Les harengs recrutés de la classe d'âge de 1998 (de 3 ans) ont dominé la pêche en 2001.

D'après des relevés acoustiques réalisés sur les frayères, nous avons estimé la biomasse du stock reproducteur (BSR) du secteur sud-ouest de la Nouvelle-Écosse/baie de Fundy à environ 507 000 t. Dans les zones de relevés habituelles, la BSR était de 370 000 t; ce qui constitue une baisse au cours des trois dernières années. Nous avons observé un plus grand nombre de reproducteurs dans la baie Scots et sur le récif de la Trinité, mais moins de harengs sur les frayères du banc German qu'au cours des dernières années. Nous avons également observé des signes que la reproduction aurait repris sur les frayères de l'île Seal, mais les niveaux actuels dans cette région et sur le récif de la Trinité demeurent bien en dessous des niveaux antérieurs.

La pêche au hareng 2001 sur les bancs de la plate-forme Scotian a produit des débarquements de 12 500 t, ce qui est considérablement plus qu'en 2000 et semblable à ceux de 1999. Les prises ont été faites surtout en mai et en juin dans la zone appelée « The Patch », dans la fosse Western et sur le banc Roseway. Tout comme au cours des quatre dernières années records, le relevé au chalut de fond de juillet a révélé une grande abondance et une vaste distribution du hareng sur les bancs situés à l'ouest de l'île de Sable.

Les modifications apportées à la gestion et les travaux de recherche récents ont permis d'améliorer nos connaissances de la pêche sur quatre frayères des côtes de la Nouvelle-Écosse, mais il manque toujours des données sur la biologie et la pêche pour la majeure partie de cette composante de reproducteurs. L'état du stock de reproducteurs du lac Bras d'Or continue de soulever des inquiétudes.

2001 Evaluation of 4VWX Herring

1) Objectives and Management

The 1999-2001 Scotia-Fundy Herring Integrated Fisheries Management Plan set out principles, conditions, and management measures for the 4VWX herring fisheries. The main principle stated in the plan was "*the conservation of the herring resource and the preservation of all of its spawning components*" (DFO 1999).

The following conservation objectives developed in 1997 (Sinclair 1997) appeared in the plan:

1) To maintain the reproductive capacity of herring in each management unit through:
- persistence of all spawning components in the management unit;
- maintenance of biomass of each spawning component above a minimum threshold;
- maintenance of a broad age composition for each spawning component; and
- maintenance of a long spawning period for each spawning component.

2) To prevent growth overfishing:
- continue to strive for fishing mortality below $F_{0.1}$

3) To maintain ecosystem integrity/ ecological relationships ("ecosystem balance").

An "in-season" management process, first implemented in the southwest Nova Scotia fishery during 1995, continued to be used widely within the 4VWX management area (DFO 1997, Stephenson et al. 1996,1999a). The approach encouraged surveying using the commercial fleet under scientific direction prior to fishing ("survey, assess, then fish" protocol) to ensure that effort was distributed appropriately among various components of the stock (particularly among spawning components) according to the relative size and current state of each component. The use of this approach in recent years has improved data collection and enabled modifications to management decisions to be made with the involvement of participants and on the basis of up-to-date information.

For the purposes of evaluation and management, the 4VWX herring stock complex is divided into four components (Fig. 1):

1. SW Nova Scotia/Bay of Fundy spawning component
2. Offshore Scotian Shelf Banks spawning component
3. Coastal (South Shore, Eastern Shore and Cape Breton) spawning component
4. SW New Brunswick migrant juveniles.

The Georges Bank spawning component (Fig. 1) is not included in this evaluation except to document Canadian herring landings from that area (Table 1).

Collaborative research efforts with the fishing industry were reduced compared with recent years (Paul 1998, 1999). The Pelagics Research Council was dissolved in 2000. A major portion of the herring industry (including the purse seine sector and major processors) formed the Herring Science Council (HSC), and some members of the fixed gear sector began forming a separate Joint Project Agreement with DFO to undertake collaborative scientific projects. The herring industry continued to provide sampling and the purse seine sector undertook key acoustic surveys.

Under the auspices of the HSC a dedicated field biologist was hired and initiatives such as tagging, summary of fleet activities (Appendix A), and analysis of acoustic records from fishing trips were resumed in 2001.

Progress in the Scotia-Fundy herring tagging program (Waters et al 2000) was restricted to two general locations. Approximately 20,000 tags were released in January 2001 and 2002 off Chebucto Head, near Halifax and 10,000 tags were applied on German Bank in Sept. 2001. Returns have been limited so far to 122 tags returned (Appendix B). Further analysis is planned after the fish have been at large for a longer period (i.e. the next assessment review).

In recent years, negative and mixed signals have prompted caution in establishment of the TAC and in the management of the fishery. Effort has been made to compile relevant information from areas that have received less research effort and are less well documented, particularly the coastal Nova Scotia (Clark et al 1999) and Scotian Shelf (Harris and Stephenson 1999) spawning components.

2) SW NOVA SCOTIA/BAY OF FUNDY SPAWNING COMPONENT

2.1 The Fishery

Herring fishing locations, NAFO unit areas used for catch and sample aggregation and fishing areas defined by groupings of 10 mile squares (i.e. 10 minute squares of latitude and longitude) are shown in Figures 2 to 5.

The 2001 catch limit for this component was 78,000t, a decrease of 22,000t from the previous year (Table 2, Figure 6). Eighty percent of the catch limit was initially allocated to the mobile gear sector and 20% to the fixed gear sector, as has been done historically. Some transfer of quota to the mobile fleet occurred late in the season.

Total landings from this component in 2001 (71,570t) were the lowest since 1998 (Table 2). Landings by the purse seine sector (66,000t) were approximately

18,000t lower than in 2000. Landings by both the gillnet sector (1,860t) and the Nova Scotia weirs (3,710t) were higher than in 2000.

The temporal and spatial distribution of the purse seine fishery was similar to previous years, but there were some changes in the relative distribution of effort (Table 3-4, Figure 7). The largest purse seine fisheries occurred on the German Bank and Scots Bay spawning grounds, and on summer feeding fish off Long Island, N.S. and around Grand Manan. Catches in Scots Bay, German Bank and on the Nova Scotia Long Island shore were about the same as in the previous year, while catches in the Gannet/Dry Ledge area and around Grand Manan were lower. There was an increase in catch in the N.B. Coastal area and on a new area, Pollock Point, west of Trinity/Lurcher which had no previous landings.

During the 1970's and 1980's, a large fishery took place on over-wintering aggregations in Chedabucto Bay. In recent years the winter fishery in Chedabucto Bay has been small and in 2001 there was no fishing effort in this area.

There was a limited amount of fishing off Halifax Harbour (Chebucto Head) after survey and tagging operations in January 2001. An acoustic survey of these overwintering herring estimated 158,000t and a fishery of 2,370t was permitted (Melvin et al. 2001). Only 472t was taken before the fish moved away from the area.

The gillnet fishery took place in the traditional areas (in June on the Spectacle Buoy area and in August/Sept. on Trinity Ledge) and increased by 1,000t or 125% over the previous year (Table 1-2, Figure 8).The relatively low landings in the gillnet sector in recent years is thought to reflect reduced effort due to lack of market and price, and the success of the recent years lobster fishery.

Catches in the Nova Scotia weirs were higher than in 2000, and near the average of recent years (Table 2) The seasonal timing of landings by month were similar to the traditional pattern seen prior to 2000 (Table 5, Figure 9). While catches in May were low, the reduction in the early season landings was not as dramatic as those seen in 2000.

2.2 Resource Status

Acoustic Surveys

Acoustic surveys were undertaken on the major spawning areas and in some of the major fishing areas. Sonars and sounders of the purse seine fleet, and sounders of the gillnet fleet were used to document the number, location and approximate size of herring schools. Data were collected during "structured surveys" (Melvin and Power 1999) and from many fishing trips (Melvin et al 2002). Biomass estimates were made using a standard length to target strength

relationship and the method used in recent assessments (Melvin et al 1998, 1999, 2000, 2001).

Acoustic surveys in 2001 documented 506,890t of spawning stock biomass (Table 6). More herring were documented in Scots Bay than in either of the two previous years. Some spawning (3,250t) was observed near Seal Island (after several years of little or no spawning). More herring were documented on Trinity Ledge but the observed SSB remains far below historical levels.

While there have been differences in survey coverage in past years, some standard areas have been surveyed consistently and well for the past three years. In 2001, SSB of 370,340t was recorded in these standard areas. There has been a decrease in SSB in these standard areas since 1999 (from 505,700t), however an additional 87,500t of spawning fish was documented near Spectacle Buoy, and if these are assumed to be from German Bank, the acoustic survey total in standard areas for 2001 would be near that of 2000. Another 45,800t were documented in a previously unsurveyed area on Brown's Bank.

The decrease in the total surveyed biomass in standard survey areas in 2001 was due to an observed reduction in SSB on German Bank. German Bank was surveyed well and the 2001 surveys are thought to be comparable to those of recent years. Although it remains the largest documented spawning area (about 200,000t), the decrease in SSB since 1999 on German Bank is unexplained and is of concern.

Fishery information shows the presence of substantial amounts of herring in some areas other than spawning grounds. Herring were abundant on summer feeding areas off south-west Nova Scotia and Grand Manan. Substantial amounts (approximately 158,000t) were documented for an overwintering aggregation off Halifax in January 2001 (Melvin et al. 2002).

Spawning ground turnover rates

The current acoustic survey method on spawning grounds is dependant on a periodic turnover of spawning fish on the grounds. Acoustic surveys are separated by at least 10 to 14 days to allow for turnover and to prevent double-counting. This aspect of the assessment method was the subject of investigation (Appendix C) with recommendations for further study as the main result.

Sampling and Catch at Age

Comprehensive biological sampling continued with substantial involvement of the fishing industry in sample collection. The distribution of samples is presented in Table 7 and the sources of samples are shown in Table 8. Sampling from the commercial fishery was well matched to the spatial temporal and distribution of the

fishery. Additional sampling from research vessel surveys during the spring and summer resulted in widespread geographic coverage as in the past (Figure 10).

Consistent with previous assessments, the catch at age was constructed using the MFD 'Catch at Age' application (version 8.03) which is a Marine Fish Division windows program for computing catch at age statistics as part of the stock assessment process. The catch at age statistics were calculated from length frequency and age length key samples. The various forms that make up Catch at Age were used to group or combine the Age Length Keys, group or combine the Length Frequencies and then apply Age Length Keys to Length Frequencies to produce Catch at Age statistics. Data files used by 'Catch at Age' were created with the 'CATCHFRM' application. CATCHFRM was used to select fish sample data from the Pelagic samples database. Data are selected from the specified databases with selection criteria provided via the CATCHFRM forms. These results include a 2% adjustment for the shrinkage due to freezing on the length measurements for frozen samples (Hunt et al. 1986).

The length-weight relationships which are also required as input to the 'Catch at Age' application were calculated using the FORTRAN program HERNLW as in the past. These were compared with a new method of calculation using an Oracle SQL*Plus script and found to be identical.

Ageing comparison tests

A set of 251 otoliths were selected from the 2001 samples for within and between age reader tests. This collection was selected so that there was approximately equal numbers by area, month and geartypes sampled during the year. There was no effort to select individual otoliths based on clarity and usually the first ten otoliths in a sample were selected. However, an effort was made to ensure that a range of ages (from 1 to 11) were present in the collection.

All otoliths were read independently by two different age readers (Ager1 and Ager2) and they were then read together in order to establish a final reference age (Agreed age) which was used in the comparisons. The age comparison matrices showed high percent agreement between agers of 82% as well as high values for the two readers compared with agreed ages of 88% and 94% (Table 9). The age statistics by age for the within reader comparisons showed low coefficients of variation, 0.91% and 1.76% respectively (Table 10). There was also very little bias in the tests for either reader (Figure 11,12). In conclusion there is no apparent problem with the ageing either between readers or for individual readers.

Age Composition of the Catch

Under $F_{0.1}$ fishing and constant average recruitment, the age composition of the population would be expected to be similar to that shown in Figure 13. There is a peak abundance at age 4, substantial fish surviving older than age 6 and a buildup

of fish at ages 11+. This expected or ideal age structure has been used in recent assessments for comparison of the actual catch at age which has been characterized by a predominance of younger ages 2-3 and few fish older than age 6 (Stephenson et al. 1999b, 2000; Power et al. 2001).

The 1998 year-class (at age 3) again dominated the catch at age as in 2000, accounting for over 55% of the numbers and 50% of the weight of herring landed (Table 11, Figure 14). These young fish were taken throughout the season and dominated all gear types except for gillnet where the mesh size used minimise their capture (Figure 15). This year class was also prominent in all areas prosecuted by the summer purse seine fishery (Table 12, Figure 16).

The historical series of catch at age was extended with the current fishing year and is shown as total number caught as well as percent by age (Table 13,14). The series shows very few fish older than age 7 in recent years and has been dominated by ages 2 and 3 since 1998 (Figure 17). The series is primarily made up of fish younger than age 6 but older ages were a feature when strong year-classes (i.e. 1976 and 1983) were progressing through the fishery (Figure 18).

The average weights at age which showed a slight increase for all ages except ages 2 and 3 (Table 15 and Fig. 19) were within the range of data observed historically.

2.3 Sources of Uncertainty

The evaluation of stock status in this area relies in large part on the spawning stock biomass estimates derived from industry acoustic surveys. There is considerable variability around acoustic estimates (standard errors are in the range of 15-45%) although studies of individual weir catches indicate that acoustic biomass estimates are within 15% of the amount of fish harvested. Uncertainty may also arise from assumptions concerning the residence time of herring on spawning grounds, target strength estimates and the coverage of surveys in relation to the extent of spawning.

While the precise strength of the recruiting 1998 year-class (age 3) is not known it appears to be strong. Observed catch information suggests this year-class is widespread and may be large.

As has been noted in previous assessments, there are very few fish older than age 7 in the catch. The rapid decline in the abundance of a year-class implies high total mortality and is consistent with heavy exploitation.

A summary of attributes used previously as biological indicators in this fishery (DFO 1997) indicate both positive and negative signs (Table 16).

2.4 Ecosystem Considerations

Herring is prominent in the diet of many fish, birds and marine mammals, and should be managed with these interactions in mind. At present, use of a natural mortality rate of 0.2 and maintenance of SSB at moderate to high levels are assumed to account for these interactions.

Recent management initiatives to protect spawning components are intended to maintain the spatial and temporal diversity of herring spawning.

2.5 Outlook

Recent assessments of the SWNS/BOF spawning component have suggested that fishing mortality should remain below $F_{0.1}$ (about 20% exploitation rate), for a number of years in order to rebuild spawning stock biomass in all spawning areas and to expand the age composition.

The last assessment (DFO 2001) suggested that there had been a deterioration rather than improvement in stock status in 2000, and noted that there had been little, if any, evidence of rebuilding of this population in the recent past when catches had been 77,000t – 85,000t. The last assessment suggested that catches for 2001 be reduced to below that of the previous three years and the catch limit was reduced.

In the 2001 fishery, there were some positive developments, but there remain some negative biological signs, and some of the conservation objectives specified for this fishery are not being met. While there is evidence of good recruitment, the population contains fewer older fish than would be expected of a balanced age distribution. The rapid decline in year-class strength is a sign of continued high total mortality. While surveyed SSB was higher in Scots Bay and on Trinity Ledge, and a small amount of spawning was observed for the first time in recent years near Seal Island the SSB on both Trinity Ledge and Seal Island is well below historical levels. Further, there has been a substantial decrease in the total biomass surveyed in index spawning areas resulting from a decrease in SSB on German Bank.

Increased catches in this fishery would be expected to contribute to rapid decline in recruiting year-classes. This would reduce the prospect of positive improvement in age composition and rebuilding SSB.

Improved prognosis for this stock requires an increase in total SSB from standard areas, adequate performance of all major spawning grounds and expanded age composition. Even with good recruitment (of the 1998 year-class), maintenance of the catch at recent levels for 2002 may not result in growth in SSB, improvement in age composition and recovery of all spawning grounds.

2.6 Management Considerations

The in-season management approach, which spreads the effort in the fishery spatially and temporally among spawning components, is seen as beneficial in achieving the conservation objectives. The "survey, assess, then fish" protocol is effective in spreading the catch appropriately among spawning components in proportion to their relative size and is considered an important safeguard at this time of uncertainty and concern regarding stock status.

Acoustic surveys have become critical to stock status evaluation. Surveys conducted in 2001 conformed with the proposed survey pattern. It is important that there be continued attention to coverage and survey design, in order to assure year-to-year consistency in these surveys.

3) OFFSHORE SCOTIAN SHELF BANKS SPAWNING COMPONENT

3.1 The Fishery

A foreign fishery during the period 1963 -1973 is estimated to have removed as much as 60,000t per year from the offshore Scotian Shelf banks. Few herring were caught after the extension of jurisdiction in 1977 until 1996, when a fishery was initiated by the 4WX purse seine fleet and 11,700t was taken (Table 1,2).

The 2001 fishery on Scotian Shelf Banks was larger than in 2000, with landings of about 12,500t. Fishing took place primarily in May and June, in the vicinity of The Patch as well as in the Western Hole/Roseway Bank areas (Figure 20).

In 2001, herring continued to be a by-catch in the domestic bottom trawl fishery on the Scotian Shelf edge and slope, but the amount was less than 50t (Figure 21). A single midwater trawl vessel was active in the area with catches of about 300t (Figure 22).

Age composition from the 2000 fishery was dominated older fish at ages 5 to 7 (Figure 23) while the 2001 fishery was dominated by the 1999 year-class (age 2) in number and the 1995 and 1996 year-classes (ages 6 and 5 respectively) in weight (Table 17, Figure 24). The large numbers of 2 year olds in the catch was due to a few landings for bait from catches in the Western Hole area. Midwater trawl catches in the 4WX offshore and Halifax purse seine catches in January 2001 were dominated by the 1998 year-class (Table 17,18).

For completeness catches by the midwater trawler on the Canadian portion of Georges Bank (area 5Z) have also been summarized (Table 18). These catches were dominated by the 1998 year-class in numbers and the 1998 and 1996 year-classes (ages 3 and 5) by weight.

3.2 Research and Industry Surveys

July Bottom Trawl Survey

The summer bottom trawl survey showed few herring on the Scotian Shelf during the 1970's, increasing amounts during the 1980's and a relatively widespread distribution in recent years (Harris and Stephenson 1999, Stephenson et al 2000). Offshore herring catches during the 2001 July bottom trawl survey were the third highest in the 31-year time series with an average of 125 fish per standard tow (Table 19, Fig. 25) for strata 55 through 78 (Fig. 27). Trends are similar for the combined strata from each of the areas 4W and 4X (Figure 26). While the 2001 catches of herring in the survey were considerably lower than in 1999, survey results of the past three years have been the highest on record in the 18 years in which the same methods have been used (Fig. 26). Herring were again widely distributed on banks west of Sable Island (Fig. 28-30).

Midwater Trawler Observations

A single vessel, equipped with a mid-water trawl made several trips to offshore areas from April through November and recorded sightings of herring (Fig. 31). Most of the information is of more relevance to Georges Bank than to the offshore Scotian Shelf banks. Herring were observed on The Patch, German Bank, Browns Bank as well as in transit to and from fishing grounds on Georges Bank.

3.3 Resource Status

A single acoustic survey by the herring fleet on July 4 documented about 145,000t in the area from The Patch to Roseway Bank. Results from the DFO summer research bottom trawl survey suggested that there were few herring on the Scotian Shelf during the 1970's, increasing amounts during the 1980's and a relatively widespread distribution in recent years. Offshore herring catches from this survey in 2001 were the second highest in the 32-year time series, with an average of 132 fish per standard tow. Survey catches of the most recent four years have been the highest on record for the past 19 years in which the same vessel and gear have been used. As in recent years, herring were widely distributed on banks west of Sable Island.

3.4 Outlook and Management Considerations

The summer bottom trawl research survey demonstrates that there is a considerable abundance of herring widely spread over the offshore banks of the Scotian Shelf. Information from previous assessments indicate the presence of at least some autumn spawning on Western Bank in recent years. There is very little new information to add and no reason to change the previous outlook:

- Recorded landings in the foreign fisheries of 13,000t to 60,000t between 1969 and 1973 did not appear to be sustainable.

- The initial catch allocation for 2002 should not exceed the 12,000t reference value used in the recent fishing plans.

There continues to be insufficient documentation of stock size, distribution and spawning behaviour for this component. Industry, DFO Science and Management are encouraged to continue to work together to improve the biological basis for management. There continues to be the need for industry surveys to estimate abundance.

4) COASTAL (SOUTH SHORE, EASTERN SHORE AND CAPE BRETON) NOVA SCOTIA SPAWNING COMPONENT

4.1 The Fishery and Resource Status

This was the sixth year for a fishery on spawning fish east of Halifax and the fifth year of gillnet roe fisheries off Little Hope and Glace Bay. Total recorded landings (6,000t) in the four major gillnet fisheries along the coast of Nova Scotia were higher for all fishing units (except for Bras d'Or Lakes which were closed) and were approximately the same as in 1999 (Table 20).

Little Hope

The fishery occurred in the Port Mouton/Little Hope area in September and October. Sampling indicated that the catch was composed primarily of 1994-1996 year-classes (ages 5-7) (Table 21, Figure 32).

A total of 2,900t of herring was landed. An estimate of 21,300t SSB was made from an automated acoustic recorder used during the fishery and over 3 survey nights.

East of Halifax (4W Eastern Shore)

The roe fishery in September and October landed 1,900t. Sampling was limited, but indicated that the catch was composed primarily of 1994-1995 year-classes (ages 7 and 6 respectively) (Table 21, Figure 33).

Acoustic surveys undertaken by the Eastern Shore Fishermen's Protective Association in October resulted in an SSB of 16,700t, the highest for the area to date (Melvin et al. 2002).

In the July groundfish survey stratum 42 (Fig. 27) covers the area of 4Vn that includes the fall roe fishery off Glace Bay. In 1999, herring catches by number

from this stratum were the highest in the past ten years (1,605 herring caught, average of 229 herring per set) and the catches by weight were the highest since 1994 (Table 18). Catches were also greater than the overall averages for the 1970s, 1980s and 1990s. It should be noted that there is a great deal of annual variability in the numbers and weights of herring caught in this survey. In 2000 overall catches of herring in this stratum were reduced and below the historical averages for the last 3 decades. In 2001 however, catches in this stratum were again up dramatically and were the highest on record (Table 22).

Glace Bay

The fishery off Glace Bay, Cape Breton took place in September and October. Landings were up, at 1,200t. Fish aged 7 (1994 year-class) dominated the catch (Table 21, Figure 34).

A mapping survey documented about 21,200t for two aggregations of spawning fish off Glace Bay (Melvin et al. 2002).

Bras d'Or Lakes

The fishery was closed. Limited sampling was undertaken by the Eskasoni Fish and Wildlife Commission in April and May 2001 with four samples taken for length (Figure 35). Survey coverage of the Bras d'Or Lakes spring spawning grounds was limited and no biomass estimates were made (Melvin et al. 2002).

4VWX Misc. Gear Catches

There were additional landings for trap and gillnet (Table 1) for which catch at age was determined from sampling data (Table 23). A single trap in 4Vn had a catch of 293t with predominantly ages 3 and 5. There was only 1t from a trap in area 4W with similar age composition assumed. Trap catches in 4X as well as miscellaneous catches from gillnet and offshore bottom trawl were combined for a total of 345t. The age composition for this group was dominated by ages 6 and 7.

3.4 Outlook and Management Considerations

In coastal Nova Scotia, there is no overall quota, and apart from the areas mentioned above, the size and historical performance of many small spawning groups are poorly documented. In addition to traditional fisheries for bait and personal use, there are new directed roe fisheries on the spawning grounds.

As the inshore roe fisheries off Glace Bay, East of Halifax and Little Hope have developed, participants have contributed to sampling and surveying and the fisheries have attempted to follow the 'survey, assess, fish' protocol. Surveys and sampling in these areas improved over previous years and should be continued.

Management approaches and recent research efforts have improved knowledge in these three areas, but there has been no increase in knowledge in adjacent areas. The lack of knowledge on the specifics of stock structure, lack of documentation of the historical fishery, and limited survey information preclude evaluation of current fishing mortality for much of this component. Individual spawning groups within this component are considered vulnerable to fishing because of their relatively small size and proximity to shore. As in the past five years, it is recommended that no coastal spawning area should experience a large effort increase until much more information is available on the state of that spawning group. There should be no new fisheries developed when there is uncertainty regarding stock composition and degree of mixing.

Since 1997 the status of herring in the Bras d'Or Lakes has been cause for concern. Spawning is still absent from some traditional areas and the observed biomass of spring spawners is very low. It is therefore appropriate to reiterate that from a biological perspective, that no fishing take place on this spawning component.

The "survey, assess, then fish (<10%)" protocol is considered useful for spawning components that are considered to be healthy and of sufficient size, but is not practical for all coastal spawning groups.

4) SW NEW BRUNSWICK MIGRANT JUVENILES

The southwest New Brunswick weir and shutoff fishery have relied, for over a century, on the aggregation of large numbers of juvenile herring (ages 1-3) near shore at the mouth of the Bay of Fundy (Figure 9,36). These have traditionally been considered to be a mixture of juveniles, dominated by fish originating from NAFO Subarea 5 spawning components, and have therefore been excluded from the 4WX quota. Mature herring (ages 4+) taken in this fishery are considered to be of 4WX origin.

The number and distribution of active weirs have decreased over the past decade, due in part to the conversion of weir sites to aquaculture, as well as the reduction in landings over the past decade in the Passamaquoddy Bay area (Table 24). The 2001 catch of 20,200t for N.B. weir and shutoffs were higher than 2000 and similar to the average since 1994(Table 2, 24 and Figure 37). Landings by month were also normal in their seasonal timing (Table 5).

The 2001 catch was dominated by the 1999 year-class (age 2), which made up almost 50% of the catch by number and by the 1998 year-class (age 3) making up over 55% of the catch by weight (Table 25, Figure 38).

The recent US management plan (NEFSC 1998) assumes that all of the juvenile herring from this fishery originate from the US "coastal complex" (5Y + 5Z) which is reported to be at record high levels of abundance.

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Table 1. 4VWX herring fishery landings (t) by month, gear sector and management unit for 2001 (calendar year).

			Month												
	Area	Gear	1	2	3	4	5	6	7	8	9	10	11	12	Total
Coastal Nova Scotia (South Shore, Eastern Shore, Cape Breton)	4Vn	Trap					30	263							293
		Bras d'Or Gillnet													-
		Glace Bay Gillnet									1,110	94			1,204
	4W	Eastern Shore Gillnet									830	1,068			1,898
		Trap							0	0					1
	4X	Little Hope Gillnet									1,133	1,771			2,904
		Trap					148	51	3	35	36				273
	4VWX	Misc. Gillnet				0	8	3	3	1			12		28
Coastal Nova Scotia Total						0	186	317	7	37	3,108	2,933	12		6,600
Offshore S.S.	4WX	Offshore P. Seine				299	2,565	8,557	268						11,689
		Halifax P. Seine	472												472
		Midwater Trawl			8		3	283					4		298
		Bottom Trawl	6	5	8	5	1	0	9	2	0	4	4	1	44
Offshore S.S. Total			478	5	16	304	2,569	8,840	277	2	0	4	8	1	12,503
S.W. Nova Scotia	4W	Fall/Winter P. Seine													-
	4X	Fall/Winter P. Seine										3,592	409		4,001
		Summer P. Seine				1	1,739	4,029	13,611	16,667	15,648	7,486			59,181
		Gillnet "Stock"						496	203	629	529				1,857
		N.S. Weirs					105	1,439	1,565	391	207				3,708
	5Y	Summer P. Seine						1,499	1,198	126					2,823
S.W. Nova Scotia Total						1	1,844	7,463	16,578	17,813	16,384	11,078	409		71,570
Migrant Juveniles	4X	N.B. Weirs					35	478	3,931	8,627	5,514	1,479			20,064
		N.B. Shutoff							33	21	92				146
Migrant Juveniles Total							35	478	3,964	8,648	5,606	1,479			20,209
Georges Bank	5ZE	5Z Purse Seine													-
		Midwater Trawl							653	949	1,146	569			3,317
Georges Bank Total									653	949	1,146	569			3,317
														Total	114,199

Table 2. Historic series of nominal and adjusted annual landings (t) by major gear components and seasons of the 4WX herring fishery, 1963-2001 (the 1963-73 Offshore Scotian Shelf landings are from Stephenson et al. (1987)).

Year^	4W Winter Purse Seine	4Xs Fall&Winter Purse Seine	4Xqr Summer Purse Seine	4X Summer Gillnet	4Xr Summer Weir	4WX Stock Nominal Landings	4WX Stock Adjusted Landings*	4WX Stock TAC	Non-Stock 4Xs Weir and Shutoff	Offshore Scotian Shelf Banks	Total 4WX Adjusted Landings
1963		6,871	15,093	2,955	5,345	30,264	30,264		29,366	3,000	62,630
1964		15991	24,894	4,053	12,458	57,396	57,396		29,432	2,000	88,828
1965		15,755	54,527	4,091	12,021	86,394	86,394		33,346	6,000	125,740
1966		25,645	112,457	4,413	7,711	150,226	150,226		35,805	2,000	188,031
1967		20,888	117,382	5,398	12,475	156,143	156,741		30,032	1,000	187,773
1968		42,223	133,267	5,884	12,571	193,945	196,362		33,145	18,000	247,507
1969	25,112	13,202	84,525	3,474	10,744	137,057	150,462		26,539	121,000	298,001
1970	27,107	14,749	74,849	5,019	11,706	133,430	190,382		15,840	87,000	293,222
1971	52,535	4,868	35,071	4,607	8,081	105,162	129,101		12,660	28,000	169,761
1972	25,656	32,174	61,158	3,789	6,766	129,543	153,449		32,699	21,000	207,148
1973	8,348	27,322	36,618	5,205	12,492	89,985	122,687		19,935	14,000	156 622
1974	27,044	10,563	76,859	4,285	6,436	125,187	149,670		20,602		170,272
1975	27,030	1,152	79,605	4,995	7,404	120,186	143,897		30,819		174,716
1976	37,196	746	58,395	8,322	5,959	110,618	115,178		29,206		144,384
1977	23,251	1,236	68,538	18,523	5,213	116,761	117,171	109,000	23,487		140,658
1978	17,274	6,519	57,973	6,059	8,057	95,882	114,000	110,000	38,842		152,842
1979	14,073	3,839	25,265	4,363	9,307	56,847	77,500	99,000	37,828		115,328
1980	8,958	1,443	44,986	19,804	2,383	77,574	107,000	65,000	13,525		120,525
1981	18,588	1,368	53,799	11,985	1,966	87,706	137,000	100,000	19,080		156,080
1982	12,275	103	64,344	6,799	1,212	84,733	105,800	80,200	25,963		131,763
1983	8,226	2,157	63,379	8,762	918	83,442	117,400	82,000	11,383		128,783
1984	6,336	5,683	58,354	4,490	2,684	77,547	135,900	80,000	8,698		144,598
1985	8,751	5,419	87,167	5,584	4,062	110,983	165,000	125,000	27,863		192,863
1986	8,414	3,365	56,139	3,533	1,958	73,409	100,000	97,600	27,883		127,883
1987	8,780	5,139	77,706	2,289	6,786	100,700	147,100	126,500	27,320		174,420
1988	8,503	7,876	98,371	695	7,518	124,653	199,600	151,200	33,421		233,021
1989	6,169	5,896	68,089	95	3,308	83,557	97,500	151,200	44,112		141,612
1990	8,316	10,705	77,945	243	4,049	102,627	172,900	151,200	38,778		211,678
1991	17,878	2,024	73,619	538	1,498	97,010	130,800	151,200	24,576		155,376
1992	14,310	1,298	80,807	395	2,227	100,227	136,000	125,000	31,967		167,967
1993	10,731	2,376	81,478	556	2,662	98,464	105,089	151,200	31,573		136,662
1994	9,872	3,174	64,509	339	2,045	80,099	80,099	151,200	22,241		102,340
1995	3,191	7,235	48,481	302	3,049	62,499	62,499	80,000	18,248		80,747
1996	2,049	3,305	42,708	6,340	3,476	58,068	58,068	57,000	15,913	11,745	85,726
1997	1,759	2,926	40,357	6,816	4,019	56,117	56,117	57,000	20,552	20,261	96,930
1998	1,405	1,494	67,433	2,231	4,464	77,027	77,027	90,000	20,091	5,591	102,709
1999	1,235	4,764	64,432	1,660	5,461	77,552	77,552	105,000	18,644	12,646	108,842
2000	1,012	4,738	78,010	823	701	85,284	85,284	100,000	16,829	2,182	104,295
2001	0	4,001	62,004	1,857	3,708	71,570	71,570	78,000	20,209	12,503	104,282

^Annual landings by purse seiners are defined for the annual plan period from October 15 of the preceding year to October 14 of the current year.
All landings by other gear types are for the calendar year.

Table 3. Summary of herring purse seine catches (t) from 1984 to 2001 by year and fishing grounds.

	Year																			
Ground	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Average 1990-2001
Browns Bank			732						86		1,903	1,554	40	14	3,139	2,197	1,137	486		1,173
Chedabucto Bay	490	4,216	7,498	6,374	7,523	8,325	12,470	12,596	3,084	1,378	1,407	2,049	1,759		1,583	1,151	10			3,749
Gannet,Dry Ledge		5,675	2,187	1,474	14,901	2,010	4,213	6,294	18,527	2,935	2,588	2,693	1,963	4,590	4,156	10,296	12,674	3,877		6,234
German Bank		15,522	13,346	16,547	18,392	8,087	11,744	23,193	3,235	4,045	9,662	19,549	15,898	13,576	20,556	24,660	25,631	24,139		16,324
Grand Manan	372	4,989	5,823	4,298	4,440	4,300	5,442	4,225	2,722	783	6,846	5,297	6,005	5,312	15,983	7,912	18,185	10,545	179	7,438
Long Island		974	3,365	7,499	10,722	21,719	18,484	9,470	3,213	2,814	7,666	7,906	4,385	3,557	12,360	18,286	11,199	12,904		9,354
Lurcher		476	132		2,928	18	65	151	2,141	1,560	530	382	243	599	57		715	227		606
N.B. Coastal	384	188	621	960	1,031	3,033	2,347	488	992	598	99	1,502	271	1,176	782	1,867	361	1,250	638	978
Pollock Point																		1,563		1,563
S.W. Grounds		558	1,108	184	181	276	56	521	225	2,961	3,444	6,205	3,035	797	1,239	3,241	1,879	53		1,971
Scots Bay			36	3,822	4,145	6,583	9,003	7,982	7,987	5,258	10,840	980	8,984	4,894	8,210	1,789	10,926	10,739		7,299
Seal Island		13,818	8,894	11,560	19,019	23,420	25,344	12,740	10,455	3,874	2,820	465	1,567	492	617	567	206	101		4,937
Trinity		35,860	13,505	18,744	18,539	266	1,113	3,259	4,612	1,348	2,366	370	3,448	5,308	2,825	1,220	103	113		2,174
Yankee Bank					194	250	3,647	817	119	10	175	323	9	4	159	82	133	8		457
Unknown	45	184	500	200			200	579	494	140		73			62	84	27			207
4WX Stock Total	1,291	82,458	57,745	71,661	102,015	78,287	94,127	82,314	57,888	27,703	50,345	49,348	47,606	40,319	71,727	73,350	83,186	66,005	817	61,993

Misc Nonstock Areas	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Average 1990-2001
Georges Bank							91	64			266		2,491	79			265			542
Liverpool								13		4,067	4,177									2,752
Shelburne				59				64		526	161		56							161
Halifax										652	1,945		585	455			1,002	472	367	852
Offshore Banks													11,800	18,770	4,284	8,669	1,645	3,977		8,191
Western Hole			41	154				213	3,451	2,255	1,495	108	127	691	1,012	1,057	47	7,712		1,652
Sydney Bight		3,511	4,250	1,751	2,100	1,330	3,591	3,606		396		3,951	4,267		52					2,644
Misc Nonstock Total		3,511	4,291	1,964	2,100	1,330	3,682	3,959	3,451	7,896	8,044	4,059	19,325	19,995	5,348	9,726	2,958	12,161	367	8,384

Overall Total	1,291	85,968	62,036	73,625	104,116	79,617	97,809	86,273	61,339	35,598	58,389	53,407	66,931	60,314	77,075	83,076	86,144	78,166	1,184	70,377

Table 4. Summary of the percentage of herring purse seine catches from 1984 to 2001 by year and fishing grounds.

Ground	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Average 1990-2001
Browns Bank			1%						0%		3%	3%	0%	0%	4%	3%	1%	1%		1%
Chedabucto Bay	38%	5%	12%	9%	7%	10%	13%	15%	5%	4%	2%	4%	3%		2%	1%	0%			4%
Gannet,Dry Ledge		7%	4%	2%	14%	3%	4%	7%	30%	8%	4%	5%	3%	8%	5%	12%	15%	5%		9%
German Bank		18%	22%	22%	18%	10%	12%	27%	5%	11%	17%	37%	24%	23%	27%	30%	30%	31%		23%
Grand Manan	29%	6%	9%	6%	4%	5%	6%	5%	4%	2%	12%	10%	9%	9%	21%	10%	21%	13%	15%	10%
Long Island		1%	5%	10%	10%	27%	19%	11%	5%	8%	13%	15%	7%	6%	16%	22%	13%	17%		13%
Lurcher		1%	0%		3%	0%	0%	0%	3%	4%	1%	1%	0%	1%	0%		1%	0%		1%
N.B. Coastal	30%	0%	1%	1%	1%	4%	2%	1%	2%	2%	0%	3%	0%	2%	1%	2%	0%	2%	54%	1%
Pollock Point																		2%		0%
S.W. Grounds		1%	2%	0%	0%	0%	0%	1%	0%	8%	6%	12%	5%	1%	2%	4%	2%	0%		3%
Scots Bay			0%	5%	4%	8%	9%	9%	13%	15%	19%	2%	13%	8%	11%	2%	13%	14%		11%
Seal Island		16%	14%	16%	18%	29%	26%	15%	17%	11%	5%	1%	2%	1%	1%	1%	0%	0%		7%
Trinity		42%	22%	25%	18%	0%	1%	4%	8%	4%	4%	1%	5%	9%	4%	1%	0%	0%		3%
Yankee Bank					0%	0%	4%	1%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%		1%
Unknown	4%	0%	1%	0%			0%	1%	1%	0%		0%			0%	0%	0%			0%
Total	100%	96%	93%	97%	98%	98%	96%	95%	94%	78%	86%	92%	71%	67%	93%	88%	97%	84%	69%	87%

Misc Nonstock Areas	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Average 1990-2001
Georges Bank							0%	0%			0%		4%	0%			0%			0%
Liverpool								0%		11%	7%									2%
Shelburne				0%				0%		1%	0%		0%							0%
Halifax										2%	3%		1%	1%			1%	1%	31%	1%
Offshore Banks													18%	31%	6%	10%	2%	5%		6%
Western Hole			0%	0%				0%	6%	6%	3%	0%	0%	1%	1%	1%	0%	10%		2%
Sydney Bight		4%	7%	2%	2%	2%	4%	4%		1%		7%	6%		0%					2%
Misc Nonstock Total		4%	7%	3%	2%	2%	4%	5%	6%	22%	14%	8%	29%	33%	7%	12%	3%	16%	31%	13%

Table 5. Monthly weir landings (t) for New Brunswick and Nova Scotia; 1978 to 2001.

		MONTH												
PROVINCE	YEAR	1	2	3	4	5	6	7	8	9	10	11	12	Year Total
N.B.	1978	3				512	802	5,499	10,275	10,877	4,972	528	132	33,599
	1979	535	96			25	1,120	7,321	9,846	4,939	5,985	2,638	74	32,579
	1980					36	119	1,755	5,572	2,352	1,016	216		11,066
	1981					70	199	4,431	3,911	2,044	2,435	1,686	192	14,968
	1982		17			132	30	2,871	7,311	7,681	3,204	849	87	22,181
	1983					65	29	299	2,474	5,382	3,945	375		12,568
	1984					6	3	230	2,344	2,581	3,045	145		8,353
	1985					22	89	4,217	8,450	6,910	4,814	2,078	138	26,718
	1986	43				17		2,480	10,114	5,997	6,233	2,564	67	27,516
	1987	39	21	6	12	10	168	2,575	10,893	6,711	5,362	703	122	26,621
	1988		12	1	90	657	287	5,993	11,975	8,375	8,457	2,343	43	38,235
	1989		24		95	37	385	8,315	15,093	10,156	7,258	2,158		43,520
	1990					93	20	4,915	14,664	12,207	7,741	168		39,808
	1991					57	180	4,649	10,319	6,392	2,028	93		23,717
	1992				15	50	774	5,477	10,989	9,597	4,395	684		31,981
	1993					14	168	5,561	14,085	8,614	2,406	470	10	31,328
	1994				18		55	4,529	10,592	3,805	1,589	30		20,618
	1995					15	244	4,517	8,590	3,956	896	10		18,228
	1996					19	676	4,819	7,767	1,917	518	65		15,781
	1997				8	153	1,017	6,506	7,396	5,316				20,396
	1998					560	713	3,832	8,295	5,604	525			19,529
	1999					690	805	5,155	9,895	2,469	48			19,063
	2000					10	7	2,105	7,533	4,940	1,713	69		16,376
	2001					35	478	3,931	8,627	5,514	1,479			20,064
N.B. Total		619	169	7	238	3,286	8,367	101,983	217,010	144,335	80,062	17,871	866	574,813
N.S.	1978				1	490	3,704	2,990	239	46	111	198	79	7,858
	1979					811	3,458	1,418	420	39	136	57		6,339
	1980					69	647	1,271	395					2,383
	1981					50	437	983	276	37		41		1,824
	1982					16	267	468	195	172	12			1,130
	1983				2	286	141	188	208	53		18		896
	1984					113	1,032	736	602	220				2,702
	1985					378	1,799	1,378	489			11		4,055
	1986					385	403	71	704	390	5			1,957
	1987					1,503	2,526	1,215	1,166	367				6,776
	1988					1,217	2,976	1,696	1,204	386				7,480
	1989					340	1,018	870	843	226				3,296
	1990					208	973	1,482	879	538	52			4,132
	1991				3	23	149	719	342	262				1,498
	1992					35	659	405	754	371				2,224
	1993					226	908	608	867	53				2,662
	1994					111	736	499	519	180				2,045
	1995					236	1,255	1,059	470	29				3,049
	1996					430	1,267	1,232	358	188				3,476
	1997					70	1,874	1,739	271	65				4,019
	1998					1,304	1,677	390	359	317				4,048
	1999					1,958	1,513	547	488	31				4,537
	2000						16	151	326	191				683
	2001					105	1,439	1,565	391	207				3,708
N.S. Total					7	10,364	30,873	23,680	12,766	4,368	315	326	79	82,778
Grand Total		619	169	7	245	13,650	39,240	125,663	229,776	148,703	80,378	18,197	945	657,591

Table 6. Summary of the minimum observed spawning stock biomass for each of the surveyed spawning grounds in the Bay of Fundy/SW Nova component of the 4WX stock complex. Note that the biomass estimates represent annual observed values and cannot be directly compared from year to year due to variation in the coverage area. (from Melvin et al, 2002 WP)

Location	1997 Observed	1998 Observed	1999 Observed	2000 Observed	2001 Observed
Scots Bay	160,168	72,473	40,972	106,316	163,900
Trinity Ledge	23,000	6,762	3,885	621	13,900
German Bank	370,400	440,704	460,823	356,372	190,500*
Spectacle B - Spring	15,000	1,329	0	0	1,140
Sub-Total	568,500	521,268	505,680	463,309	368,300
Additional:					
Spectacle B - Fall					87,500
Seal Island					3,250
Browns Bank					45,800
Total					504,850

* German Bank Sept 23 not included

Table 7. Summary of biological samples (by fishery and month) taken in the 2001 4VWX herring fisheries.

		Month											
Gearname	Data	1	2	3	4	5	6	7	8	9	10	11	Gear Total
4W Purse Seine	NO_LF						49						49
	NO_MEAS						6339						6339
	Aged						37						37
Gillnet	NO_LF				3	1	2	1	7	10	10	11	45
	NO_MEAS				76	228	225	111	895	1320	490	792	4137
	Aged				0	0	53	0	53	52	158	197	513
Midwater Trawl	NO_LF						6						6
	NO_MEAS						743						743
	Aged						48						48
N.B. Purse Seine	NO_LF					15	56	39	3	5	46		164
	NO_MEAS					1734	5881	4427	302	590	5468		18402
	Aged					52	182	140	0	80	167		621
N.B. Shut-off	NO_LF							3	2	1			6
	NO_MEAS							334	209	112			655
	Aged							0	0	0			0
N.B. Weirs	NO_LF					1	24	111	227	171	49		583
	NO_MEAS					104	2568	12254	23902	19193	5248		63269
	Aged					17	102	159	173	171	83		705
N.S. Purse Seine	NO_LF	6			2	52	68	92	166	156	24		566
	NO_MEAS	1086			427	7689	8577	12707	22021	19462	2813		74782
	Aged	208			19	153	196	154	469	1143	51		2393
N.S. Weirs	NO_LF					3	48	34	15	6			106
	NO_MEAS					325	5333	3606	1428	569			11261
	Aged					0	171	316	127	27			641
Resrch. Otter Trawl	NO_LF		63	21				69			15		168
	NO_MEAS										1317		1317
	Aged		879	278				889			306		2352
Trap	NO_LF							1					1
	NO_MEAS							243					243
	Aged							0					0
4Vn Trap	NO_LF						1						1
	NO_MEAS						290						290
	Aged						0						0
5Y CAN P.Seine	NO_LF						16	13	2	1			32
	NO_MEAS						1959	1408	242				3609
	Aged						0	43	0	10			53
5Y USA P.Seine/MWT	NO_LF					6							6
	NO_MEAS					623							623
	Aged					0							0
5Z USA P.Seine/MWT	NO_LF	2		1									3
	NO_MEAS	223		131									354
	Aged	0		0									0
5Z CAN MW Trawl	NO_LF							18	17	12	5		52
	NO_MEAS							3558	3020	1773	875		9226
	Aged							0	106	40	39		185
Total NO_LF		8	63	22	5	78	270	381	439	362	149	11	1788
Total NO_MEAS		1309		131	503	10703	31915	38648	52019	43019	16211	792	195250
Total Aged		208	879	278	19	222	789	1701	928	1523	804	197	7548

Table 8. Number of herring samples collected by DFO personnel from commercial fisheries (Commercial), by members of the fishing industry (Industry), observer program (Observer), independent observers on foreign vessels (OSS) and DFO research surveys (Research).

	Sample Source					
Year	Commercial	Industry	Observer	OSS	Research	Total
1990	422			185		607
1991	448			167	1	616
1992	330			205	1	536
1993	183			421		604
1994	223			228	14	465
1995	138			244	108	490
1996	127	868	49		69	1,113
1997	78	1,443			114	1,635
1998	225	1,376			98	1,699
1999	49	1,388	89		198	1,724
2000	34	1,387	108		177	1,706
2001	47	1,455	96		190	1,788
Average	**192**	**1,320**	**86**	**242**	**97**	**1,082**

Table 9. Ageing agreement comparison matrices for a) ager1 vs ager 2 b) ager2 vs agreed ages c) ager1 vs agreed ages.

A- Ager1 vs Ager2

	Ager2-3											
Ager1-1	1	2	3	4	5	6	7	8	9	10	11	Total
1	**12**											12
2		**17**										17
3			**76**	2								80
4			6	**10**	3							19
5				7	**45**	2						54
6					3	**16**	8					27
7						5	**18**	1	1			25
8							3	**6**				9
9								2	**1**			3
10										**2**		2
11										1	**2**	3
Total	12	17	84	19	51	23	29	9	2	3	2	251

B- Age-Agreed vs Ager2

	Ager2-3											
Age-Agreed	1	2	3	4	5	6	7	8	9	10	11	Total
1	**12**											12
2		**17**										17
3			**81**	1								82
4			3	**11**	2							16
5				7	**46**	1						54
6					3	**18**	4					25
7						4	**24**	1				29
8							1	**6**				7
9								2	**2**			4
10										**2**		2
11										1	**2**	3
Total	12	17	84	19	51	23	29	9	2	3	2	251

C- Age-Agreed vs Ager1

	Ager1-1											
Age-Agreed	1	2	3	4	5	6	7	8	9	10	11	Total
1	**12**											12
2		**17**										17
3			**79**	3								82
4			1	**15**								16
5				1	**52**	1						54
6					2	**22**	1					25
7						4	**23**	2				29
8								**7**				7
9							1		**3**			4
10										**2**		2
11											**3**	3
Total	12	17	80	19	54	27	25	9	3	2	3	251

Table 9. Ageing agreement comparison matrices for a) ager1 vs ager 2 b) ager2 vs agreed ages c) ager1 vs agreed ages.

A- Ager1 vs Ager2

	Ager2-3											
Ager1-1	1	2	3	4	5	6	7	8	9	10	11	Total
1	12											12
2		17										17
3			78	2								80
4			6	13	3							19
5				7	45	2						54
6					3	24	8					27
7						5	20	1	1			25
8							3	6				9
9								2	1			3
10										2		2
11										1	2	3
Total	12	17	84	19	51	23	29	9	2	3	2	251

B- Age-Agreed vs Ager2

	Ager2-3											
Age-Agreed	1	2	3	4	5	6	7	8	9	10	11	Total
1	12											12
2		17										17
3			81	1								82
4			3	11	2							16
5				7	45	1						54
6					3	18	4					25
7						4	24	1				29
8							1	6				7
9								2	2			4
10										2		2
11										1	2	3
Total	12	17	84	19	51	23	29	9	2	3	2	251

C- Age-Agreed vs Ager1

	Ager1-1											
Age-Agreed	1	2	3	4	5	6	7	8	9	10	11	Total
1	12											12
2		17										17
3			77	3								82
4			1	15								16
5				1	51	1	1					54
6					2	22	1					25
7						4	24	2				29
8								7				7
9							1		3			4
10										2		2
11											3	3
Total	12	17	80	19	54	27	25	9	3	2	3	251

Table 10. Ageing statistics for within reader tests a) ager1 vs agreed ages and b) ager2 vs agreed ages.

A- Ager1 vs Agreed Age statistics by age

Agreed Age	N	Mean	Std. Dev.	Conf. Int. 95%	Coefficient of Variation
1	12	1.00			
2	17	2.00			
3	82	3.04	0.19	0.04	0.86%
4	16	3.94	0.25	0.12	1.10%
5	54	5.00	0.19	0.05	0.52%
6	25	5.96	0.35	0.14	1.41%
7	29	6.93	0.46	0.17	2.09%
8	7	8.00			
9	4	8.50	1.00	0.98	3.93%
10	2	10.00			
11	3	11.00			
Total/Avg.	251	4.47	2.03	0.25	0.91%

B- Ager2 vs Agreed Age statistics by age

Agreed Age	N	Mean	Std. Dev.	Conf. Int. 95%	Coefficient of Variation
1	12	1.00			
2	17	2.00			
3	82	3.01	0.11	0.02	1.41%
4	16	3.94	0.57	0.28	4.51%
5	54	4.89	0.37	0.10	1.92%
6	25	6.04	0.54	0.21	3.08%
7	29	6.90	0.41	0.15	2.05%
8	7	7.86	0.38	0.28	
9	4	8.50	0.58	0.57	1.96%
10	2	10.00			
11	3	10.67	0.58	0.65	2.14%
Total/Avg.	251	4.43	2.02	0.25	1.76%

Table 11. Herring catch at age for the 2001 purse seine, weir and gillnet fisheries conducted on the southwest Nova Scotia spawning component (4WX stock).

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	51	73,368	325,273	57,175	60,409	31,891	15,509	2,203	304	8	4	566,193	
% numbers	0%	13%	57%	10%	11%	6%	3%	0%	0%	0%	0%	100%	
Catch wt. (t)	1	4,240	35,113	8,593	11,474	7,246	4,152	646	99	3	2	71,570	
% catch wt.	0%	6%	49%	12%	16%	10%	6%	1%	0%	0%	0%	100%	
Avg. len (cm)	15.2	20.0	24.2	26.8	28.7	30.3	31.9	32.7	34.1	35.5	37.0	25.0	Overall Avg. len.
Avg. wt. (g)	22.4	57.8	108.0	150.3	189.9	227.2	267.7	293.1	327.0	369.5	453.7	126.4	Overall Avg. wt.

Catch at age for 2001 southwest Nova Scotia stock component by gear type.

Catch Numbers (000's)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
4W Purse Seine												0
4X Summer Purse Seine	30	34,493	279,770	52,628	54,858	28,012	13,428	1,966	288	8	0	465,480
4X Fall/Winter Purse Seine	11	16,783	26,779	1,829	594	194	64	4	0	0	0	46,258
4X N.S. Weir	10	22,072	17,663	1,783	2,139	1,108	679	70	2	0	4	45,531
4X Gillnet	0	19	1,061	935	2,819	2,577	1,337	162	13	0	0	8,924
Total Numbers by Age	51	73,368	325,273	57,175	60,409	31,891	15,509	2,203	304	8	4	566,193

Percent Numbers	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
4W Purse Seine	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4X Summer Purse Seine	0%	7%	60%	11%	12%	6%	3%	0%	0%	0%	0%	100%
4X Fall/Winter Purse Seine	0%	36%	58%	4%	1%	0%	0%	0%	0%	0%	0%	100%
4X N.S. Weir	0%	48%	39%	4%	5%	2%	1%	0%	0%	0%	0%	100%
4X Gillnet	0%	0%	12%	10%	32%	29%	15%	2%	0%	0%	0%	100%
Percent Numbers by Age	0%	13%	57%	10%	11%	6%	3%	0%	0%	0%	0%	100%

Catch Weight (t)	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
4W Purse Seine												0
4X Summer Purse Seine	1	2,233	30,818	7,937	10,407	6,348	3,586	576	94	3	0	62,004
4X Fall/Winter Purse Seine	0	1,115	2,494	234	101	40	16	1	0	0	0	4,001
4X N.S. Weir	0	888	1,667	270	410	260	189	21	1	0	2	3,708
4X Gillnet	0	4	134	153	556	598	361	47	4	0	0	1,857
Total Weight (t) by Age	1	4,240	35,113	8,593	11,474	7,246	4,152	646	99	3	2	71,570

Percent Weight	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total
4W Purse Seine	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
4X Summer Purse Seine	0%	4%	50%	13%	17%	10%	6%	1%	0%	0%	0%	100%
4X Fall/Winter Purse Seine	0%	28%	62%	6%	3%	1%	0%	0%	0%	0%	0%	100%
4X N.S. Weir	0%	24%	45%	7%	11%	7%	5%	1%	0%	0%	0%	100%
4X Gillnet	0%	0%	7%	8%	30%	32%	19%	3%	0%	0%	0%	100%
Percent Weight by Age	0%	6%	49%	12%	16%	10%	6%	1%	0%	0%	0%	100%

Table 12. Herring catch at age by NAFO unit area for the 2001 summer purse seine fishery conducted on the southwest Nova Scotia spawning component (4WX stock).

Summer Purse - overall

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	30	34,493	279,770	52,628	54,858	28,012	13,428	1,966	288	8	-	465,480	
% numbers	0%	7%	60%	11%	12%	6%	3%	0%	0%	0%	0%	100%	
Catch wt. (t)	1	2,233	30,818	7,937	10,407	6,348	3,586	576	94	3	-	62,004	
% catch wt.	0%	4%	50%	13%	17%	10%	6%	1%	0%	0%	0%	100%	
Avg. len (cm)	15.4	20.8	24.4	26.8	28.7	30.3	31.9	32.7	34.1	35.5			25.5 Avg. Len
Avg. wt. (g)	23.1	64.8	110.2	150.8	189.7	226.6	267.1	293.2	326.8	369.5			133.2 Avg. wt

5Yb Purse	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	131	16,817	1,908	1,990	666	151	18	1	-	-	21,683	
% numbers	0%	1%	78%	9%	9%	3%	1%	0%	0%	0%	0%	100%	
Catch wt. (t)	-	15	1,951	282	379	148	41	6	0	-	-	2,823	
% catch wt.	0%	1%	69%	10%	13%	5%	1%	0%	0%	0%	0%	100%	
Avg. len (cm)	-	24.4	24.5	26.4	28.5	29.9	31.8	32.9	33.5	-			25.3 Avg. Len
Avg. wt. (g)	-	115.9	116.0	148.1	190.7	221.9	271.0	299.9	305.1	-			130.2 Avg. wt

4Xs Purse	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	9	13,591	33,949	2,638	2,021	791	407	45	2	-	-	53,453	
% numbers	0%	25%	64%	5%	4%	1%	1%	0%	0%	0%	0%	100%	
Catch wt. (t)	0	878	3,201	378	380	182	113	14	1	-	-	5,147	
% catch wt.	0%	17%	62%	7%	7%	4%	2%	0%	0%	0%	0%	100%	
Avg. len (cm)	14.3	20.9	23.2	26.3	28.5	30.2	31.9	32.9	34.0	-			23.1 Avg. Len
Avg. wt. (g)	18.5	64.6	94.3	143.1	186.1	230.2	277.9	309.7	343.1	-			96.3 Avg. wt

4Xr Purse	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	21	16,192	133,090	19,084	16,844	7,022	3,419	371	19	-	-	196,062	
% numbers	0%	8%	68%	10%	9%	4%	2%	0%	0%	0%	0%	100%	
Catch wt. (t)	1	1,011	14,245	2,827	3,186	1,604	945	114	7	-	-	23,940	
% catch wt.	0%	4%	60%	12%	13%	7%	4%	0%	0%	0%	0%	100%	
Avg. len (cm)	15.9	20.6	24.2	26.6	28.6	30.2	31.9	33.0	33.9	-			24.8 Avg. Len
Avg. wt. (g)	25.0	62.4	107.0	148.2	189.1	228.5	276.4	308.4	338.1	-			122.1 Avg. wt

4Xq Purse	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	4,526	93,342	28,444	33,411	19,283	9,407	1,530	266	8	-	190,218	
% numbers	0%	2%	49%	15%	18%	10%	5%	1%	0%	0%	0%	100%	
Catch wt. (t)	-	324	11,131	4,374	6,357	4,361	2,476	442	87	3	-	29,555	
% catch wt.	0%	1%	38%	15%	22%	15%	8%	1%	0%	0%	0%	100%	
Avg. len (cm)	-	21.4	25.1	27.0	28.8	30.3	31.8	32.7	34.1	35.5			26.9 Avg. Len
Avg. wt. (g)	-	71.6	119.3	153.8	190.3	226.2	263.2	288.9	325.9	369.5			155.4 Avg. wt

4Xpo Purse	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	52	2,571	554	592	250	44	1	-	-	-	4,065	
% numbers	0%	1%	63%	14%	15%	6%	1%	0%	0%	0%	0%	100%	
Catch wt. (t)	-	5	289	76	105	53	11	0	-	-	-	539	
% catch wt.	0%	1%	54%	14%	19%	10%	2%	0%	0%	0%	0%	100%	
Avg. len (cm)	-	23.9	24.9	26.4	28.5	30.1	31.4	32.5	-	-			26.0 Avg. Len
Avg. wt. (g)	-	98.8	112.5	136.7	176.7	211.9	245.5	291.7	-	-			132.6 Avg. wt

Table 13. Catch at age (millions) for the Southwest Nova Scotia / Bay of Fundy herring spawning component, 1965-2001.

	Year											
Year	1	2	3	4	5	6	7	8	9	10	11+	Total
1965	270	1,085	35	234	50	11	2	1	0	0	0	1,687
1966	154	914	449	73	322	46	14	8	2	0	0	1,982
1967	722	614	154	266	110	159	58	4	0	0	0	2,089
1968	165	2,389	225	83	290	73	91	32	15	6	1	3,370
1969	109	290	532	132	162	113	63	23	6	3	1	1,433
1970	700	577	77	286	201	120	112	41	21	7	3	2,145
1971	88	404	184	107	114	76	94	50	37	8	6	1,165
1972		649	72	149	77	75	49	49	26	14	12	1,172
1973	1	167	781	131	40	30	22	20	24	12	13	1,242
1974	18	766	94	804	68	19	10	7	13	7	9	1,815
1975	3	318	240	125	515	66	12	4	5	4	6	1,298
1976	0	56	207	154	69	269	21	6	4	2	3	790
1977	1	154	32	218	119	51	177	14	3	1	4	775
1978	35	384	41	13	122	68	31	109	11	2	2	819
1979	0	184	250	55	5	23	18	12	41	5	2	596
1980	2	13	81	474	28	4	5	7	3	11	3	629
1981		103	51	103	451	33	2	3	2	1	2	751
1982	4	102	151	23	98	211	15	2	1	1	1	609
1983	5	192	150	244	24	61	90	10	2	1	1	781
1984		88	244	224	146	23	22	28	10	2	9	796
1985	9	217	338	303	148	42	14	18	8	1	0	1,098
1986	0	125	276	293	57	32	11	4	3	1	0	802
1987	2	83	126	527	243	46	19	7	3	3	1	1,062
1988	0	148	113	195	434	236	43	21	4	4	3	1,202
1989	0	102	114	62	79	169	77	18	8	4	3	636
1990		179	130	172	90	101	202	117	31	11	7	1,039
1991		97	179	184	88	41	50	81	46	18	14	798
1992	0	169	133	287	127	75	34	35	59	35	21	974
1993	0	76	44	194	131	68	34	21	22	21	11	622
1994	0	104	142	54	118	73	36	15	9	10	16	576
1995	2	113	220	112	37	36	22	6	4	3	4	560
1996		37	38	256	55	17	9	3	2	1	2	420
1997	0	57	87	78	131	19	5	4	1	1	1	384
1998	0	265	62	139	97	97	21	4	2	1	0	689
1999	3	113	223	148	131	57	10	1	0	0	0	686
2000	1	364	75	109	124	61	26	4	0	0	0	764
2001	0	73	325	57	60	32	16	2	0	0	0	566

Table 14. Catch at age (%) for the Southwest Nova Scotia / Bay of Fundy herring spawning component, 1965-2001.

	Year											
Year	1	2	3	4	5	6	7	8	9	10	11+	Total
1965	16	64	2	14	3	1	0	0	0	0	0	100
1966	8	46	23	4	16	2	1	0	0	0	0	100
1967	35	29	7	13	5	8	3	0	0	0	0	100
1968	5	71	7	2	9	2	3	1	0	0	0	100
1969	8	20	37	9	11	8	4	2	0	0	0	100
1970	33	27	4	13	9	6	5	2	1	0	0	100
1971	8	35	16	9	10	6	8	4	3	1	0	100
1972	-	55	6	13	7	6	4	4	2	1	1	100
1973	0	13	63	11	3	2	2	2	2	1	1	100
1974	1	42	5	44	4	1	1	0	1	0	0	100
1975	0	24	18	10	40	5	1	0	0	0	0	100
1976	0	7	26	19	9	34	3	1	0	0	0	100
1977	0	20	4	28	15	7	23	2	0	0	1	100
1978	4	47	5	2	15	8	4	13	1	0	0	100
1979	0	31	42	9	1	4	3	2	7	1	0	100
1980	0	2	13	75	4	1	1	1	0	2	0	100
1981	-	14	7	14	60	4	0	0	0	0	0	100
1982	1	17	25	4	16	35	2	0	0	0	0	100
1983	1	25	19	31	3	8	12	1	0	0	0	100
1984	-	11	31	28	18	3	3	4	1	0	1	100
1985	1	20	31	28	13	4	1	2	1	0	0	100
1986	0	16	34	36	7	4	1	1	0	0	0	100
1987	0	8	12	50	23	4	2	1	0	0	0	100
1988	0	12	9	16	36	20	4	2	0	0	0	100
1989	0	16	18	10	12	27	12	3	1	1	0	100
1990	-	17	13	17	9	10	19	11	3	1	1	100
1991	-	12	22	23	11	5	6	10	6	2	2	100
1992	0	17	14	29	13	8	4	4	6	4	2	100
1993	0	12	7	31	21	11	5	3	4	3	2	100
1994	0	18	25	9	20	13	6	3	2	2	3	100
1995	0	20	39	20	7	7	4	1	1	1	1	100
1996	-	9	9	61	13	4	2	1	0	0	0	100
1997	0	15	23	20	34	5	1	1	0	0	0	100
1998	0	38	9	20	14	14	3	1	0	0	0	100
1999	0	16	33	22	19	8	1	0	0	0	0	100
2000	0	48	10	14	16	8	3	1	0	0	0	100
2001	0	13	57	10	11	6	3	0	0	0	0	100

Table 15. Average weights at age (g) for the SW Nova Scotia component of the 4WX herring fishery (weighted by fishery) for 1965-2001 (values for 1979-83 are averages for the period 1968-78 as in Iles et al. 1984).

	Year									
Year	1	2	3	4	5	6	7	8	9	10
1965	10	41	112	172	218	254	286	323	354	389
1966	10	41	112	172	218	254	286	323	354	389
1967	10	41	112	172	218	254	286	323	354	389
1968	10	33	112	148	185	244	276	399	338	410
1969	10	37	105	162	207	242	282	306	334	390
1970	10	32	119	169	211	257	292	332	369	389
1971	10	66	143	199	230	254	293	329	362	388
1972	10	44	138	192	223	262	292	322	345	380
1973	10	29	106	143	225	252	279	331	360	389
1974	10	48	110	175	206	240	277	322	342	352
1975	10	21	94	179	216	240	268	333	358	379
1976	10	33	114	159	233	249	277	317	382	404
1977	10	65	113	174	214	274	293	325	328	416
1978	10	28	112	181	229	259	302	330	351	397
1979	**10**	**41**	**112**	**172**	**218**	**254**	**286**	**323**	**354**	**389**
1980	**10**	**41**	**112**	**172**	**218**	**254**	**286**	**323**	**354**	**389**
1981	**10**	**41**	**112**	**172**	**218**	**254**	**286**	**323**	**354**	**389**
1982	**10**	**41**	**112**	**172**	**218**	**254**	**286**	**323**	**354**	**389**
1983	**10**	**41**	**112**	**172**	**218**	**254**	**286**	**323**	**354**	**389**
1984	10	38	132	191	229	259	280	296	309	364
1985	10	53	118	204	249	278	315	334	344	440
1986	10	55	124	182	239	271	306	329	360	400
1987	12	50	98	153	199	245	274	290	318	350
1988	13	21	88	154	196	242	281	304	327	341
1989	7	33	79	162	207	238	274	303	324	353
1990	10	31	92	161	200	234	255	287	319	336
1991	10	48	100	147	186	217	251	270	303	322
1992	9	25	100	148	181	216	252	275	295	313
1993	18	29	108	153	188	215	251	279	302	324
1994	12	37	79	131	175	203	223	253	289	304
1995	15	42	76	136	187	223	247	293	300	326
1996	10	33	98	137	168	228	266	308	332	355
1997	19	34	80	161	190	238	284	314	358	376
1998	10	38	76	131	177	210	251	296	308	337
1999	20	42	75	120	172	220	263	304	344	378
2000	26	61	95	138	171	206	235	269	316	360
2001	22	58	108	150	190	227	268	293	327	370

Table 15. Average weights at age (g) for the SW Nova Scotia component of the 4WX herring fishery (weighted by fishery) for 1965-2001 (values for 1979-83 are averages for the period 1968-78 as in Iles et al. 1984).

	Year									
Year	1	2	3	4	5	6	7	8	9	10
1965	10	41	112	172	218	254	286	323	354	389
1966	10	41	112	172	218	254	286	323	354	389
1967	10	41	112	172	218	254	286	323	354	389
1968	10	33	112	148	185	244	276	399	338	410
1969	10	37	105	162	207	242	282	306	334	390
1970	10	32	119	169	211	257	292	332	369	389
1971	10	66	143	199	230	254	293	329	362	388
1972	10	44	138	192	223	262	292	322	345	380
1973	10	29	106	143	225	252	279	331	360	389
1974	10	48	110	175	206	240	277	322	342	352
1975	10	21	94	179	216	240	268	333	358	379
1976	10	33	114	159	233	249	277	317	382	404
1977	10	65	113	174	214	274	293	325	328	416
1978	10	28	112	181	229	259	302	330	351	397
1979	10	41	112	172	218	254	286	323	354	389
1980	10	41	112	172	218	254	286	323	354	389
1981	10	41	112	172	218	254	286	323	354	389
1982	10	41	112	172	218	254	286	323	354	389
1983	10	41	112	172	218	254	286	323	354	389
1984	10	38	132	191	229	259	280	296	309	364
1985	10	53	118	204	249	278	315	334	344	440
1986	10	55	124	182	239	271	306	329	360	400
1987	12	50	98	153	199	245	274	290	318	350
1988	13	21	88	154	196	242	281	304	327	341
1989	7	33	79	162	207	238	274	303	324	353
1990	10	31	92	161	200	234	255	287	319	336
1991	10	48	100	147	186	217	251	270	303	322
1992	9	25	100	148	181	216	252	275	295	313
1993	18	29	108	153	188	215	251	279	302	324
1994	12	37	79	131	175	203	223	253	289	304
1995	15	42	76	136	187	223	247	293	300	326
1996	10	33	98	137	168	228	266	308	332	355
1997	19	34	80	161	190	238	284	314	358	376
1998	10	38	76	131	177	210	251	296	308	337
1999	20	42	75	120	172	220	263	304	344	378
2000	26	61	95	138	171	206	235	269	316	360
2001	22	58	108	150	190	227	268	293	327	370

Table 16. 2001 fishery observations for the SW Nova Scotia spawning component: summary of attributes used previously as biological indicators (DFO 1997).

Biological Attribute	Positive	Negative
Spawning time	Normal in most areas; protracted on Trinity	
Spawning location	Spawning reappeared on Seal Island after several years	
Spawning:relative amount	More SSB observed in Scots Bay and Trinity Ledge; some observed on Seal Island	Reduced SSB on German Bank; SSB well below historical levels on Trinity and Seal Island
Size/Age composition	Strong recruiting 1998 year-class	Few fish older than age 7
Distribution	As expected in most key over-wintering, summer feeding and spawning areas	Spawners found north-east of German Bank outside of traditional spawning area.
Relative fish abundance	Lots of fish, good catch rate and trip success	
Physiology, condition & behaviour	Nothing unusual noted; fat content as expected	

Table 17. 2001 4WX offshore herring purse seine, midwater trawl and Halifax fisheries catch at age.

4WX Offshore Purse
Catch at age (number and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	234	66,981	25,700	4,822	13,311	10,985	5,582	714	57	14	-	126,402	
% numbers	0%	52%	20%	4%	10%	9%	4%	1%	0%	0%	0%	100%	
Catch wt. (t)	3	1,761	2,157	768	2,643	2,584	1,528	218	22	6	-	11,690	
% catch wt.	0%	15%	18%	7%	23%	22%	13%	2%	0%	0%	0%	100%	
Avg. len (cm)	12.5	15.5	22.1	27.0	28.9	30.4	31.9	32.9	35.3	36.5		20.7	Avg. Len
Avg. wt. (g)	12.8	26.3	83.9	159.4	198.6	235.2	273.8	305.5	383.4	426.3		91.0	Avg. wt

4WX Midwater Trawl
Catch at age (numbers and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	5	844	146	332	306	143	13	-	-	-	1,789	
% numbers	0%	0%	47%	8%	19%	17%	8%	1%	0%	0%	0%	100%	
Catch wt. (t)	-	1	93	23	66	73	38	4	-	-	-	298	
% catch wt.	0%	0%	31%	8%	22%	24%	13%	1%	0%	0%	0%	100%	
Avg. len (cm)	-	25.0	24.2	27.1	28.9	30.5	31.7	32.4	-	-		27.0	Avg. Len
Avg. wt. (g)	-	124.1	110.7	159.7	198.1	237.4	269.1	288.0	-	-		166.6	Avg. wt

Halifax P.Seine
Catch at age (numbers and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	12	1,979	1,109	1,172	167	71	-	4	-	-	4,514	
% numbers	0%	0%	44%	25%	26%	4%	2%	0%	0%	0%	0%	100%	
Catch wt. (t)	-	0	153	115	158	30	15	-	1	-	-	472	
% catch wt.	0%	0%	33%	24%	33%	6%	3%	0%	0%	0%	0%	100%	
Avg. len (cm)	-	14.2	23.0	25.3	27.5	30.0	31.3	-	35.0	-		25.1	Avg. Len
Avg. wt. (g)	-	17.3	77.5	103.8	134.7	177.6	203.9	-	289.3	-		104.6	Avg. wt

Table 18. 2001 4WX and 5Z midwater trawl fisheries catch at age.

4WX Midwater Trawl
Catch at age (numbers and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	5	844	146	332	306	143	13	-	-	-	1,789	
% numbers	0%	0%	47%	8%	19%	17%	8%	1%	0%	0%	0%	100%	
Catch wt. (t)	-	1	93	23	66	73	38	4	-	-	-	298	
% catch wt.	0%	0%	31%	8%	22%	24%	13%	1%	0%	0%	0%	100%	
Avg. len (cm)	-	25.0	24.2	27.1	28.9	30.5	31.7	32.4	-	-		27.0	Avg. Len
Avg. wt. (g)	-	124.1	110.7	159.7	198.1	237.4	269.1	288.0	-	-		166.6	Avg. wt

5Z Midwater Trawl
Catch at age (numbers and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	13	8,307	2,467	5,811	3,078	839	66	2	-	-	20,583	
% numbers	0%	0%	40%	12%	28%	15%	4%	0%	0%	0%	0%	100%	
Catch wt. (t)	-	1	943	376	1,078	679	219	20	1	-	-	3,317	
% catch wt.	0%	0%	28%	11%	33%	20%	7%	1%	0%	0%	0%	100%	
Avg. len (cm)	-	22.6	25.0	27.1	28.8	30.2	31.9	33.0	34.5	-		27.4	Avg. Len
Avg. wt. (g)	-	79.0	113.5	152.4	185.6	220.5	261.4	302.4	329.5	-		161.2	Avg. wt

Table 19. Herring abundance indices: larval abundance index (average number of larvae per m² from 79 index stations) and herring by-catch (stratified numbers per tow) from the July groundfish survey.

Larval Herring Bongo Survey No per m2 to bottom					Summer groundfish by-catch (mean nos per tow for herring)									
					4WX area combined strata 453/495				4W Only strata 453/466		4X Only strata 470/495		Offshore Banks strata 455/478	
Year	Cruise	Mean	SE	N	Cruise	Mean#	SE	N	Mean#	SE	Mean#	SE	Mean#	SE
1970					A175/176	4.1	1.5	95	4.9	2.4	1.6	0.6		
1971					A188/189	4.0	1.9	86	2.6	1.2	3.6	2.6		
1972	P109	9.4	1.8	79	A200/201	1.4	0.6	105	1.7	1.0	0.5	0.1		
1973	P127	6.6	1.3	79	A212/213	0.9	0.3	96	0.4	0.3	1.0	0.4		
1974	P147	49.5	10.9	79	A225/226	0.7	0.3	102	0.2	0.0	1.0	0.4		
1975	P160	11.7	1.5	58	A236/237	0.9	0.4	104	0.8	0.4	0.7	0.4		
1976	P175	13.5	2.9	79	A250/251	0.4	0.2	103	0.1	0.1	0.5	0.3		
1977	P190	6.3	1.0	79	A265/266	0.5	0.3	106	0.0	0.0	0.8	0.5		
1978	P207	4.5	0.5	77	A279/280	0.3	0.3	103	0.5	0.5	0.1	0.0		
1979	P232	7.1	2.1	79	A292/293	0.6	0.5	106	0.0	0.0	1.0	0.7		
1980	P246	26.2	6.7	79	A306/307	0.5	0.5	105	0.0	0.0	0.8	0.8		
1981	P263	2.7	0.3	78	A321/322	1.5	1.4	104	0.0	0.0	2.3	2.1		
1982	P280	10.6	1.2	77	H080/081	1.5	0.9	108	0.5	0.3	1.9	1.4		
1983	P298	13.9	1.6	74	N012/013	2.4	0.8	106	2.6	1.2	2.2	1.0	2.1	1.0
1984	P315	12.7	1.4	78	N031/032	7.0	3.5	102	3.3	1.2	10.5	6.8	8.5	5.4
1985	P329	40.8	4.6	79	N048/049	3.4	1.8	111	6.6	3.8	0.3	0.1	5.0	2.9
1986	P344	18.9	2.1	78	N065/066	23.2	14.9	118	30.8	26.7	16.0	14.3	23.4	20.3
1987	P361	27.9	3.2	78	N85/86/87	10.4	5.6	135	17.0	11.3	4.0	1.8	12.9	8.6
1988	P377	100.7	11.5	76	N105/106	2.1	0.6	127	2.7	1.2	1.5	0.5	2.0	0.9
1989	P391	54.5	6.1	79	N123/124	8.4	1.8	124	11.8	3.4	4.5	1.2	9.8	2.7
1990	P408	27.2	3.1	79	N139/140	5.6	1.9	156	7.4	3.6	3.4	1.0	6.5	2.9
1991	P422	48.2	5.5	78	N154/H231	10.6	5.8	137	13.0	8.8	5.0	1.8	14.3	9.0
1992	P437	57.0	6.4	79	N173/174	16.5	4.9	136	16.2	6.6	40.8	15.7	23.6	7.4
1993	P451	55.0	6.2	78	N189/190	18.7	4.5	137	6.3	2.5	30.4	8.5	15.0	4.7
1994	N211	5.4	0.7	77	N221/222	76.4	30.2	140	108.4	58.9	45.9	18.4	91.1	45.1
1995	N232	20.3	4.6	78	N226/227	63.5	24.2	140	100.5	47.9	28.4	12.8	92.7	37.6
1996	N252	9.5	1.6	77	N246/247	40.2	14.2	135	53.2	24.5	27.1	14.1	46.5	19.5
1997	N765	23.3	2.7	77	N726/734	31.8	15.3	137	34.6	10.1	51.3	39.3	29.3	7.7
1998	N865	33.6	3.8	77	N827/832	99.52	20.65	131	147.6	39.92	54.76	14.5	130.3	30.3
1999	no survey				N925/929	229.8	83.8	133	264.2	101.0	199.4	130.2	226.2	74.4
2000	no survey				N426/431	90.6	20.0	146	146.3	40.6	38.7	7.4	124.7	30.5
2001	no survey				N2001-032/037	145.9	47.7	139	152.7	81.3	139.5	52.5	132.4	60.9

Table 20. Recorded landings (t) of herring from major gillnet fisheries on the Coastal Nova Scotia Spawning component.

Landings (t)

	1996	1997	1998	1999	2000	2001
East of Halifax	1,280	1,520	1,100	1,628	1,350	1,898
Little Hope	-	490	1,170	2,919	2,043	2,904
Glace Bay	-	170	1,730	1,040	834	1,204
Bras d'Or Lakes	170	160	120	31	56	0
Total	1,450	2,340	4,120	5,618	4,283	6,006

Table 21. Catch at age for herring from Coastal Nova Scotia fisheries in 2001.

Sept. to Oct., 2001 4X Little Hope Gillnet
Catch at age (number and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	3	210	700	4,045	4,464	3,254	610	34	-	-	13,319	
% numbers	0%	0%	2%	5%	30%	34%	24%	5%	0%	0%	0%	100%	
Catch wt. (t)	-	0	27	116	757	988	832	171	12	-	-	2,904	
% catch wt.	0%	0%	1%	4%	26%	34%	29%	6%	0%	0%	0%	100%	
Avg. len (cm)	-	24.5	25.8	27.8	29.0	30.5	31.8	32.6	34.7	-		30.2	Avg. Len
Avg. wt. (g)	-	106.3	129.9	165.9	187.1	221.4	255.7	281.0	354.8	-		218.0	Avg. wt

2001 4W Eastern Shore herring gillnet
Catch at age (number and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	-	-	96	1,651	3,444	2,953	345	8	-	-	8,497	
% numbers	0%	0%	0%	1%	19%	41%	35%	4%	0%	0%	0%	100%	
Catch wt. (t)	-	-	-	16	304	750	733	93	3	-	-	1,898	
% catch wt.	0%	0%	0%	1%	16%	40%	39%	5%	0%	0%	0%	100%	
Avg. len (cm)	-	-	-	28.1	29.0	30.5	31.8	32.6	34.0	-		30.7	Avg. Len
Avg. wt. (g)	-	-	-	167.0	184.1	217.9	248.1	268.1	308.2	-		223.4	Avg. wt

2001 Glace Bay herring gillnet
Catch at age (numbers and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	2	9	56	458	990	1,580	1,103	176	15	2	4,391	
% numbers	0%	0%	0%	1%	10%	23%	36%	25%	4%	0%	0%	100%	
Catch wt. (t)	-	0	1	10	90	237	446	350	63	7	1	1,204	
% catch wt.	0%	0%	0%	1%	8%	20%	37%	29%	5%	1%	0%	100%	
Avg. len (cm)	-	19.8	25.8	28.0	29.3	30.8	32.3	33.5	34.6	36.4	36.0	32.0	Avg. Len
Avg. wt. (g)	-	54.5	131.3	171.2	197.5	239.1	282.4	317.1	355.6	424.5	407.6	274.2	Avg. wt

2001 Bras d'Or Lakes herring gillnet
Catch at age (number and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	-	-	-	0	3	12	9	6	2	0	32	
% numbers	0%	0%	0%	0%	1%	8%	36%	29%	19%	7%	0%	100%	
Catch wt. (t)	-	-	-	-	0	1	3	3	2	1	0	10	
% catch wt.	0%	0%	0%	0%	1%	6%	33%	29%	22%	8%	0%	100%	
Avg. len (cm)	-	-	-	-	30.2	31.3	33.2	34.2	35.3	36.6	37.5	33.9	Avg. Len
Avg. wt. (g)	-	-	-	-	211.9	236.7	285.9	314.8	348.8	388.9	421.2	308.4	Avg. wt

Table 22. Summary of herring catches for the 4Vn inshore area (stratum 42) during the July groundfish survey;1990 to 2001 in numbers and weight (kg).

Year	Total Number	Average No. Per Set	Total Weight	Average Wt. Per Set
1990	1	0	0	0
1991	11	2	4	1
1992	0	0	0	0
1993	13	3	4	1
1994	1,301	217	432	72
1995	359	60	80	13
1996	0	0	0	0
1997	2	0	1	0
1998	37	7	6	1
1999	1,605	229	431	62
2000	42	7	11	2
2001	2,938	490	944	157
1970-79 Avg.	91	35	39	6
1980-89 Avg.	699	171	195	75
1990-01 Avg.	526	85	159	26

Table 23. 2001 4Vn trap, 4W trap and 4VWX misc fisheries catch at age.

4Vn Trap
Catch at age (numbers and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	3	357	141	292	272	286	75	2	5	-	1,435	
% numbers	0%	0%	25%	10%	20%	19%	20%	5%	0%	0%	0%	100%	
Catch wt. (t)	-	0	36	22	58	65	84	25	1	2	-	293	
% catch wt.	0%	0%	12%	8%	20%	22%	29%	8%	0%	1%	0%	100%	
Avg. len (cm)	-	21.4	23.5	27.0	28.9	30.6	32.5	33.7	35.0	36.5		28.7	Avg. Len
Avg. wt. (g)	-	76.2	101.1	158.0	197.8	238.9	292.8	328.6	372.5	428.0		204.2	Avg. wt

4W Trap
Catch at age (numbers and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	0	1	1	2	1	0	0	0	0	0	5	
% numbers	0%	0%	25%	21%	32%	14%	6%	1%	0%	0%	0%	100%	
Catch wt. (t)	-	0	0	0	0	0	0	0	0	0	0	1	
% catch wt.	0%	0%	18%	18%	33%	17%	9%	2%	0%	0%	1%	99%	
Avg. len (cm)	-	28.2	25.6	27.0	28.5	30.3	31.9	33.9	35.0	36.0	37.0	28.0	Avg. Len
Avg. wt. (g)	-	186.2	135.1	161.4	192.2	234.3	278.4	341.3	378.8	414.4	453.7	185.5	Avg. wt

4VWX Misc
Catch at age (numbers and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	2	116	62	219	281	421	187	73	28	1	1,390	
% numbers	0%	0%	8%	4%	16%	20%	30%	13%	5%	2%	0%	100%	
Catch wt. (t)	-	0	13	10	43	65	118	58	25	11	1	345	
% catch wt.	0%	0%	4%	3%	12%	19%	34%	17%	7%	3%	0%	100%	
Avg. len (cm)	-	27.3	24.7	27.4	29.1	30.7	32.8	33.9	35.3	36.6	37.5	31.2	Avg. Len
Avg. wt. (g)	-	162.5	116.5	161.2	196.8	232.8	280.3	309.9	347.6	389.0	421.0	248.2	Avg. wt

Table 24. Weir catches (t), number of active weirs and the catch per weir, 1978 to 2001.

	Catch (t)			No. Active Weirs			Catch per Weir		
Year	NB	NS	Total Catch	NB	NS	Total No.	NB	NS	Average
1978	33,599	7,858	41,458	208	31	239	162	253	173
1979	32,579	6,339	38,918	210	27	237	155	235	164
1980	11,066	2,383	13,449	120	29	149	92	82	90
1981	14,968	1,824	16,793	147	28	175	102	65	96
1982	22,181	1,130	23,311	159	19	178	140	59	131
1983	12,568	896	13,464	143	23	166	88	39	81
1984	8,353	2,702	11,056	116	13	129	72	208	86
1985	26,718	4,055	30,774	156	14	170	171	290	181
1986	27,516	1,957	29,473	105	18	123	262	109	240
1987	26,621	6,776	33,397	123	21	144	216	323	232
1988	38,235	7,480	45,715	191	21	212	200	356	216
1989	43,520	3,296	46,817	171	20	191	255	165	245
1990	39,808	4,132	43,940	154	22	176	258	188	250
1991	23,717	1,498	25,216	143	20	163	166	75	155
1992	31,981	2,224	34,206	151	12	163	212	185	210
1993	31,328	2,662	33,990	145	10	155	216	266	219
1994	20,618	2,045	22,662	129	11	140	160	186	162
1995	18,228	3,049	21,277	106	10	116	172	305	183
1996	15,781	3,476	19,257	101	12	113	156	290	170
1997	20,396	4,019	24,415	102	15	117	200	268	209
1998	19,529	4,048	23,577	108	15	123	181	270	192
1999	19,063	4,537	23,600	100	14	114	191	324	207
2000	16,376	683	17,058	77	3	80	213	228	213
2001	20,064	3,708	23,772	101	14	115	199	265	207
Totals	574,813	82,778	657,591	3266	422	3688	176	196	178

Table 25. New Brunswick weir and shut-off catch at age for herring in 2001.

2001 NB Weir and Shutoff combined
Catch at age (numbers and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	1,120	119,056	114,831	8,310	4,738	1,619	346	38	-	-	-	250,058	
% numbers	0%	48%	46%	3%	2%	1%	0%	0%	0%	0%	0%	100%	
Catch wt. (t)	17	6,510	11,156	1,201	872	355	89	11	-	-	-	20,210	
% catch wt.	0%	32%	55%	6%	4%	2%	0%	0%	0%	0%	0%	100%	
Avg. len (cm)	13.4	19.8	23.4	26.5	28.6	30.1	31.6	32.3	-	-		21.9	Avg. Len
Avg. wt. (g)	15.3	54.7	97.2	144.5	184.1	219.1	256.7	281.1	-	-		80.8	Avg. wt

NB Weirs (only)
Catch at age (numbers and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	1,120	117,154	114,371	8,298	4,735	1,619	346	38	-	-	-	247,681	
% numbers	0%	47%	46%	3%	2%	1%	0%	0%	0%	0%	0%	100%	
Catch wt. (t)	17	6,401	11,121	1,199	872	355	89	11	-	-	-	20,064	
% catch wt.	0%	32%	55%	6%	4%	2%	0%	0%	0%	0%	0%	100%	
Avg. len (cm)	13.4	19.8	23.4	26.5	28.6	30.1	31.6	32.3	-	-		21.9	Avg. Len
Avg. wt. (g)	15.3	54.6	97.2	144.5	184.1	219.1	256.7	281.1	-	-		81.0	Avg. wt

NB Shutoff (only)
Catch at age (numbers and weight)

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11+	Total	
Numbers (x1,000)	-	1,902	460	12	2	-	-	-	-	-	-	2,377	
% numbers	0%	80%	19%	1%	0%	0%	0%	0%	0%	0%	0%	100%	
Catch wt. (t)	-	109	35	2	0	-	-	-	-	-	-	146	
% catch wt.	0%	75%	24%	1%	0%	0%	0%	0%	0%	0%	0%	100%	
Avg. len (cm)	-	20.1	21.8	26.5	28.0	-	-	-	-	-		20.5	Avg. Len
Avg. wt. (g)	-	57.2	76.2	142.7	170.5	-	-	-	-	-		61.4	Avg. wt

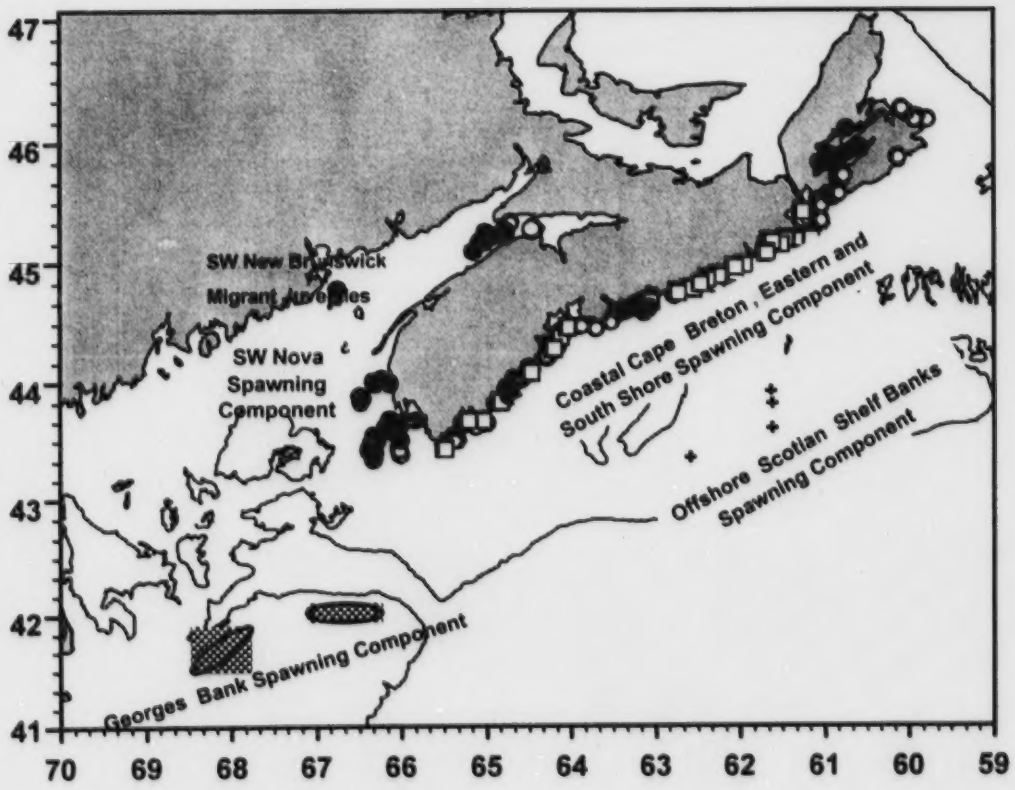

Figure 1. Management units for herring in areas 4VWX and 5 showing locations of known current (solid) and historical (open) spawning locations.

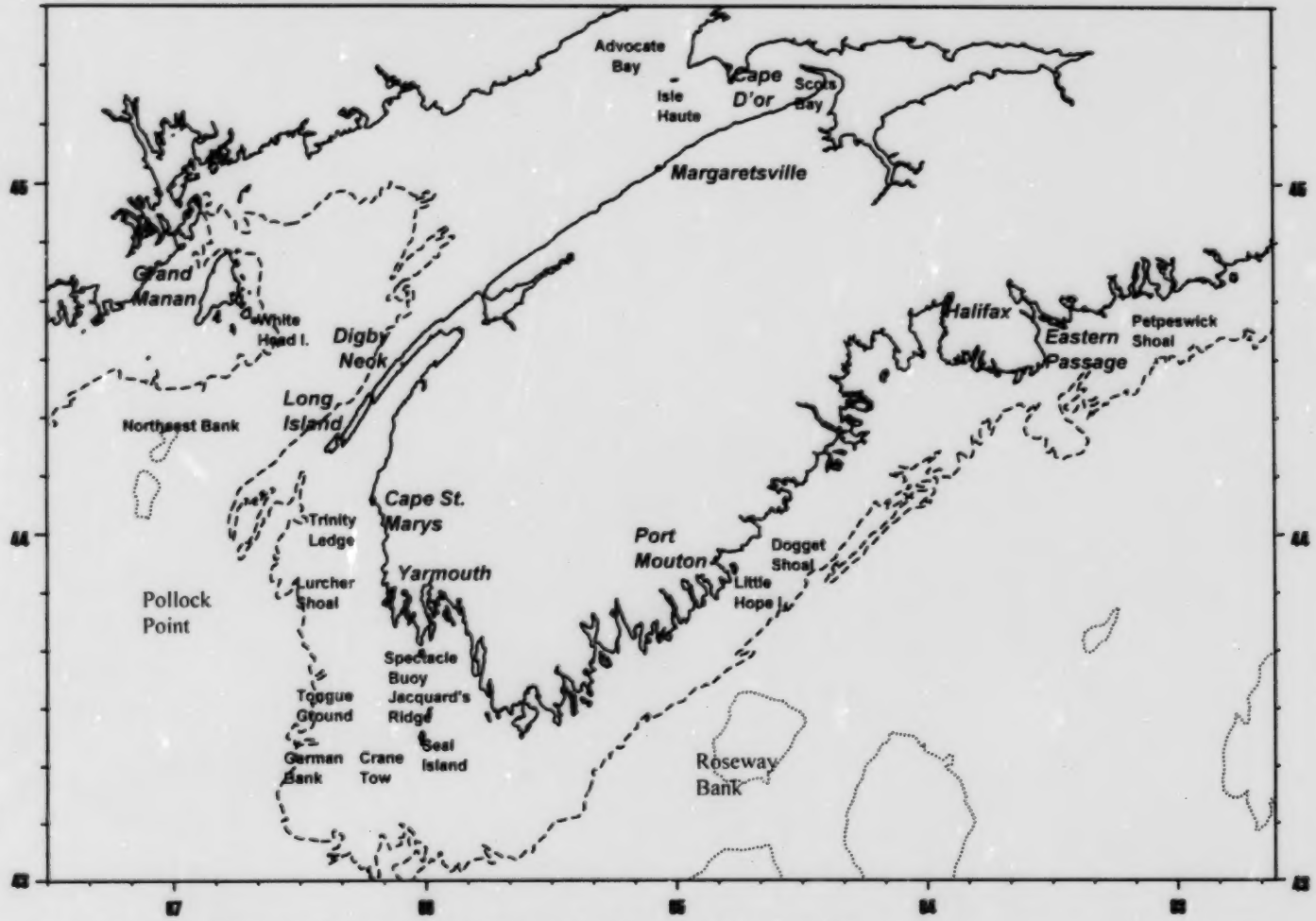

Figure 2. Fishing locations for herring in southwest and coastal Nova Scotia.

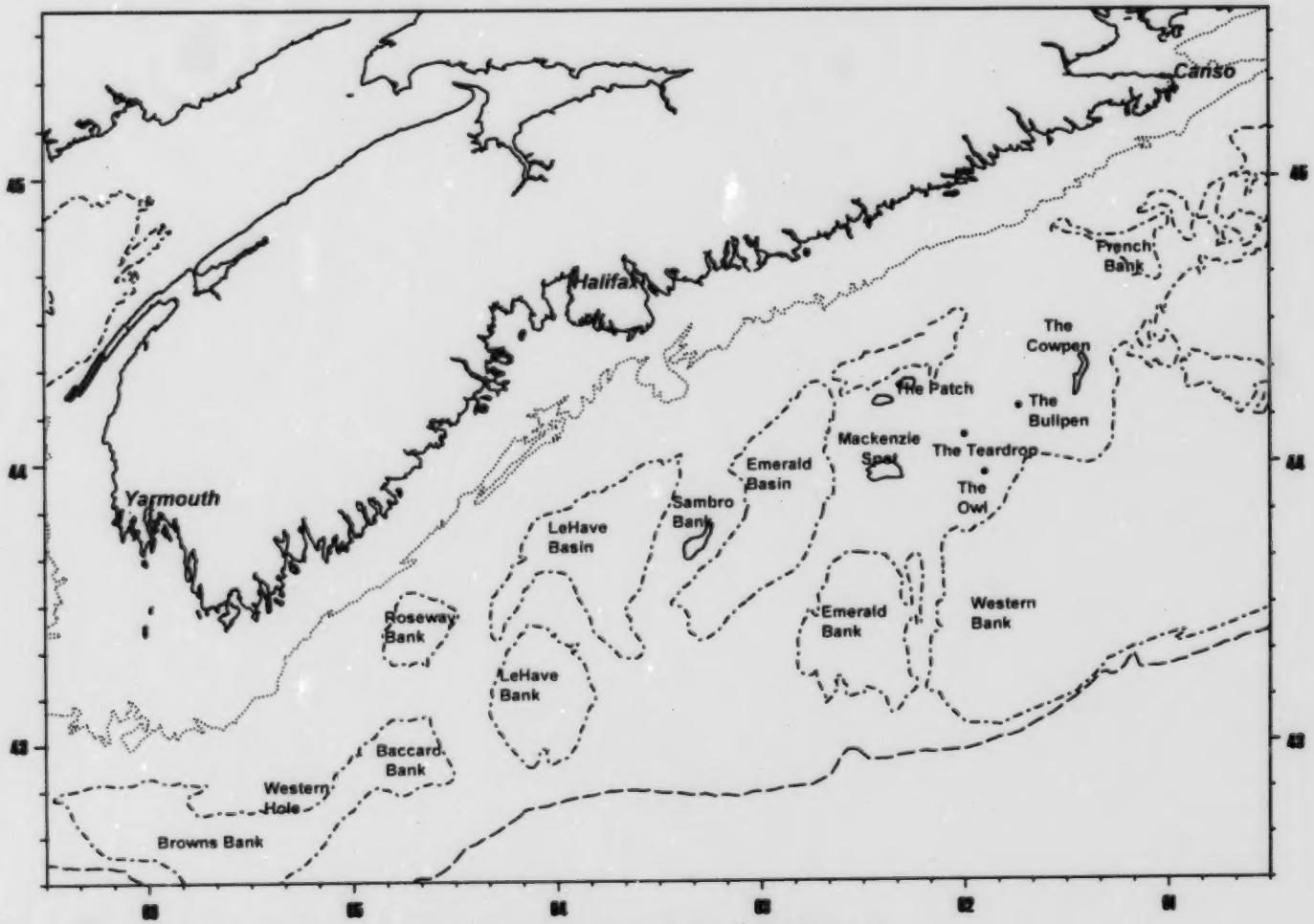

Figure 3. Fishing locations for herring on the offshore Scotian Shelf banks.

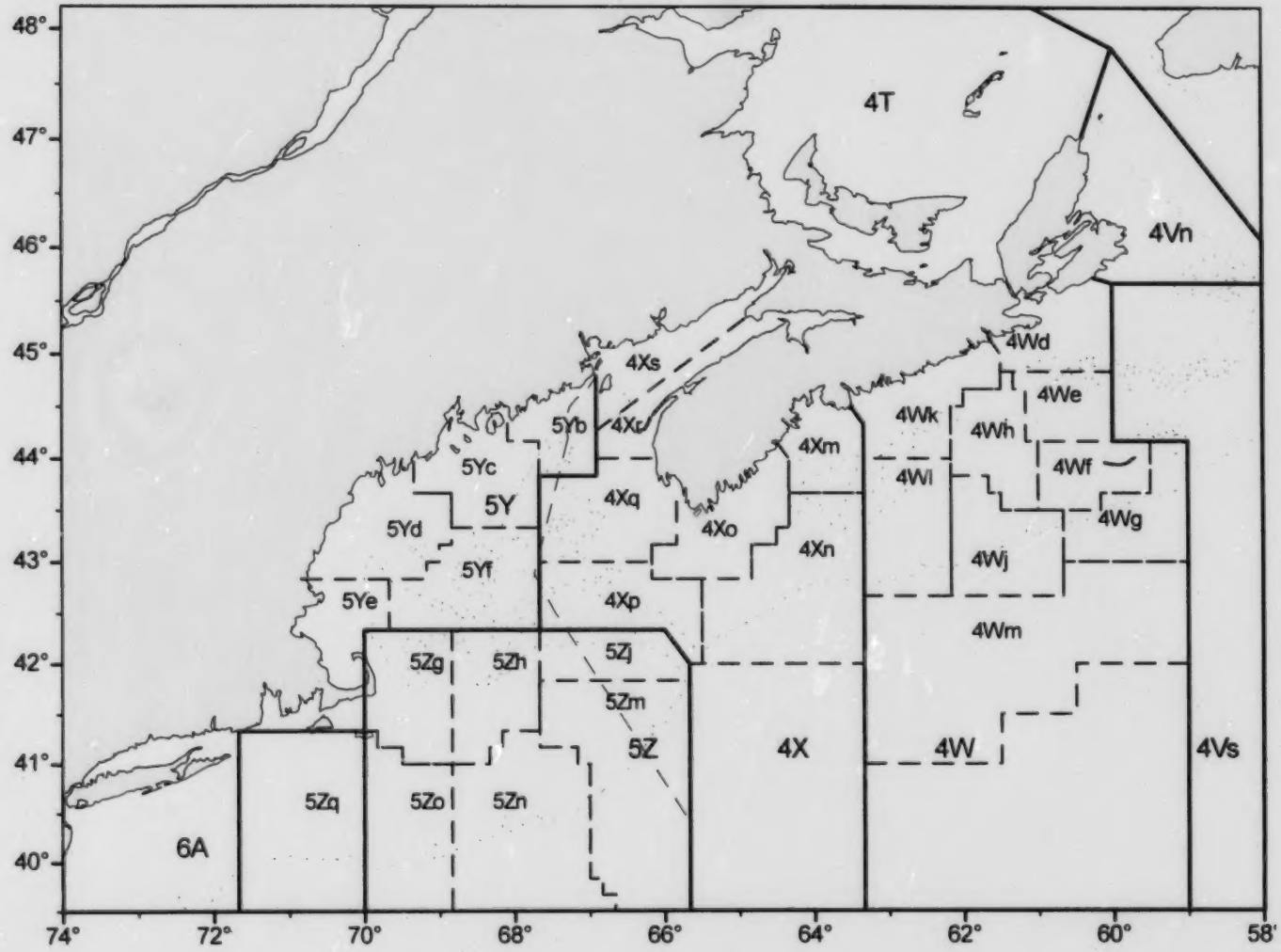

Figure 4. Major and minor NAFO unit areas as used for sample and catch data aggregation.

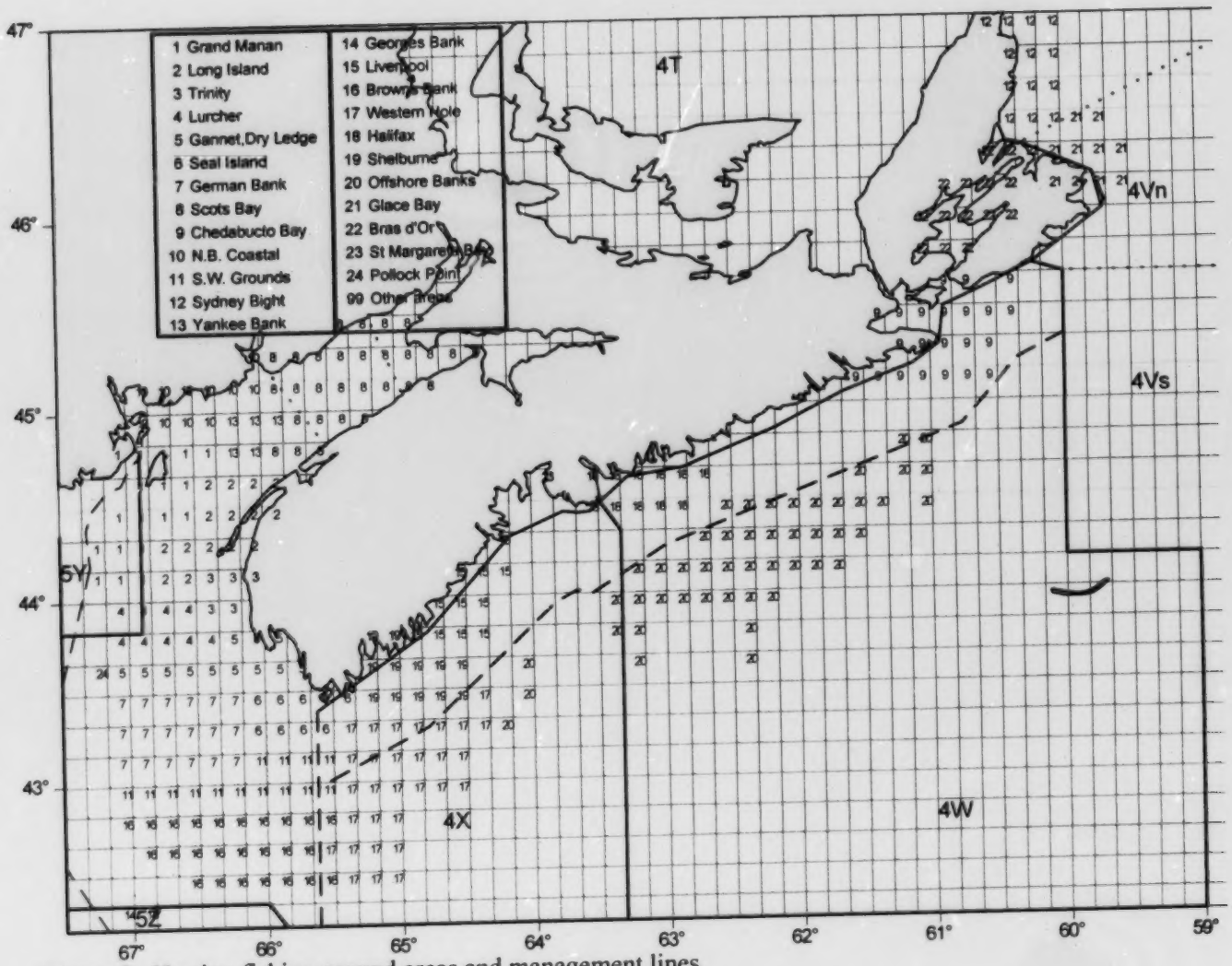

Figure 5. Herring fishing ground areas and management lines.

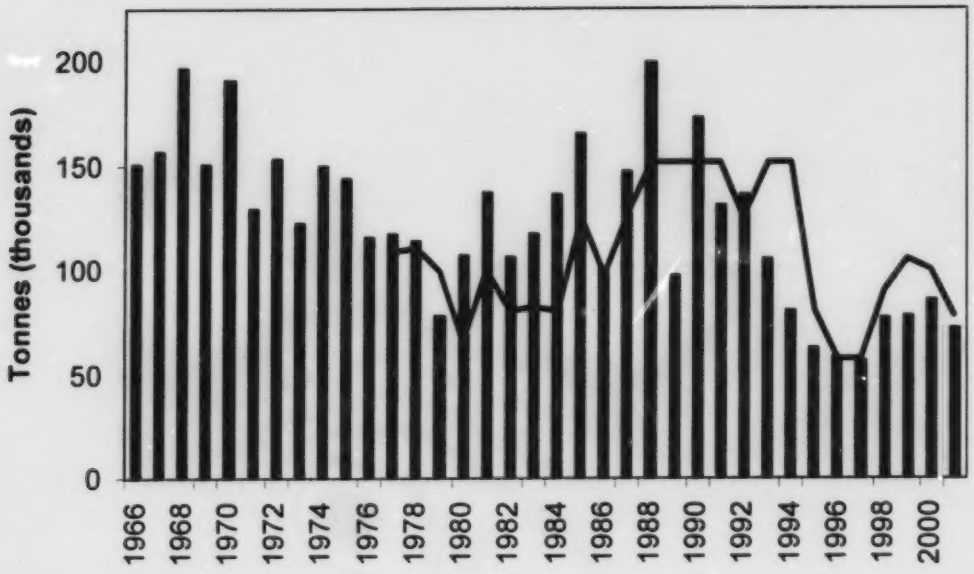

Figure 6. Annual herring landings and TAC (quota) for the southwest Nova Scotia spawning component (4WX stock).

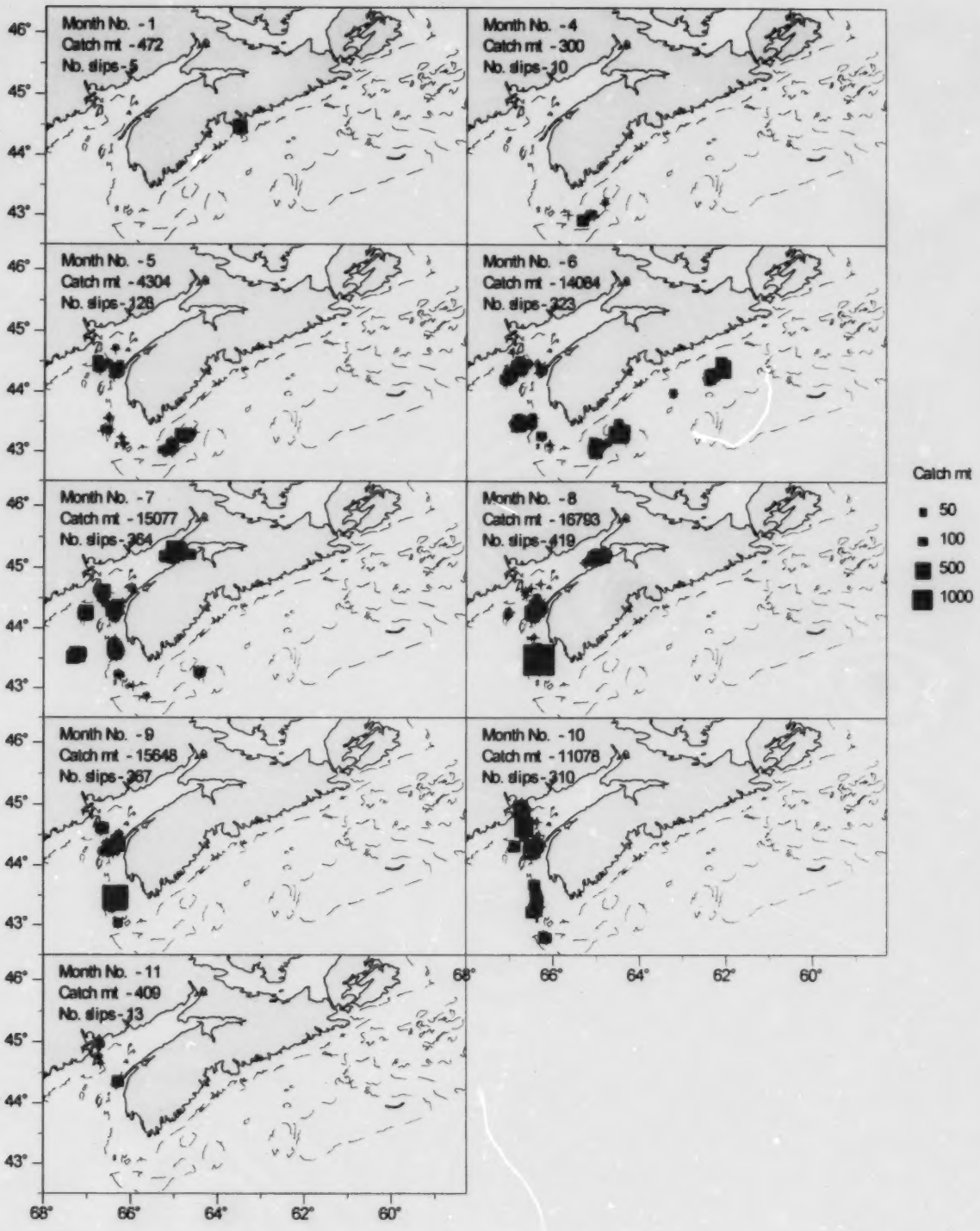

Figure 7. 2001 herring purse seine catches (t) for NAFO areas 4VWX by month (data from Statistics Division ZIF database).

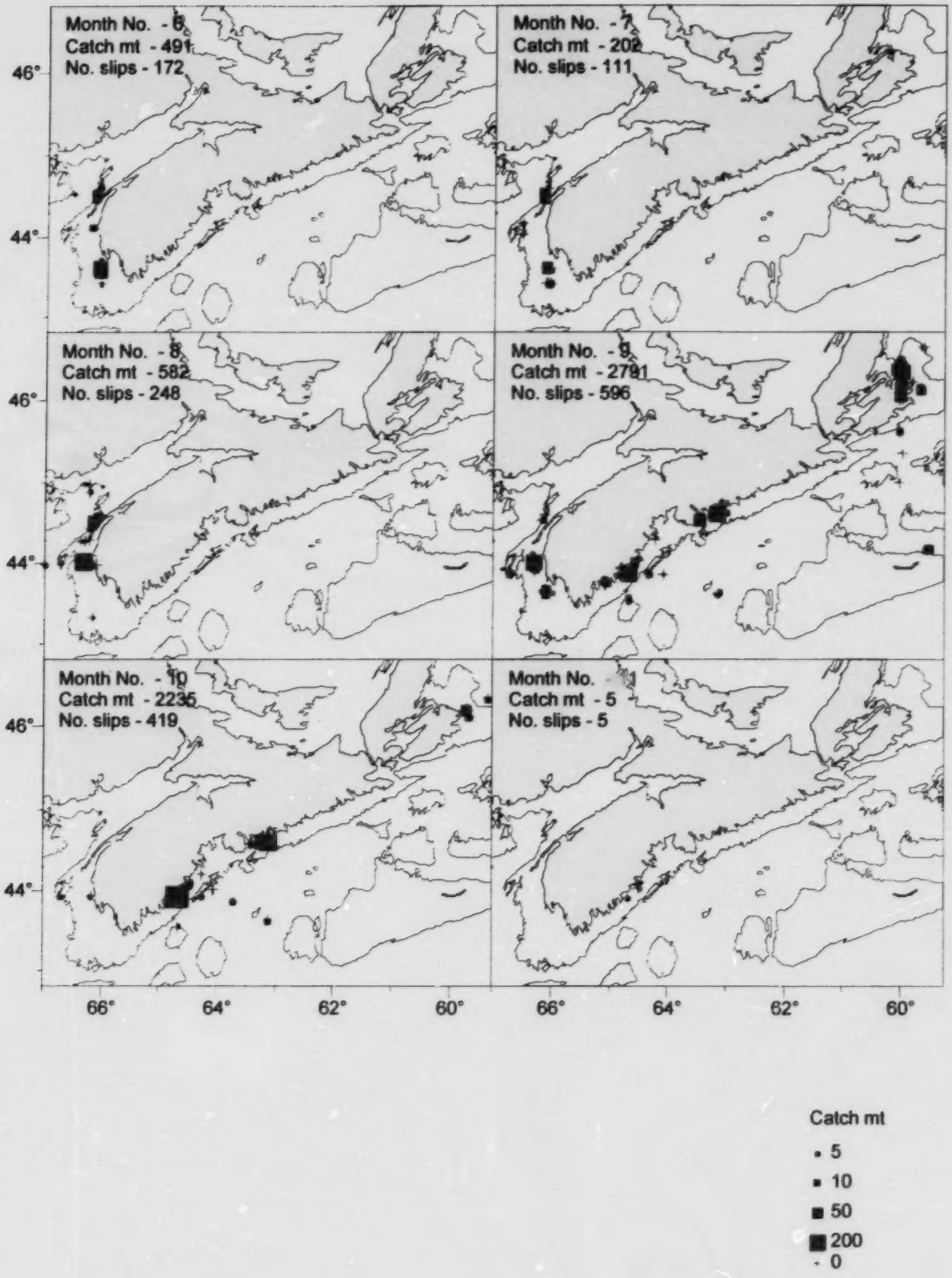

Figure 8. 2001 herring gillnet catches (t) for NAFO areas 4VWX by month (data from Statistics Division ZIF database).

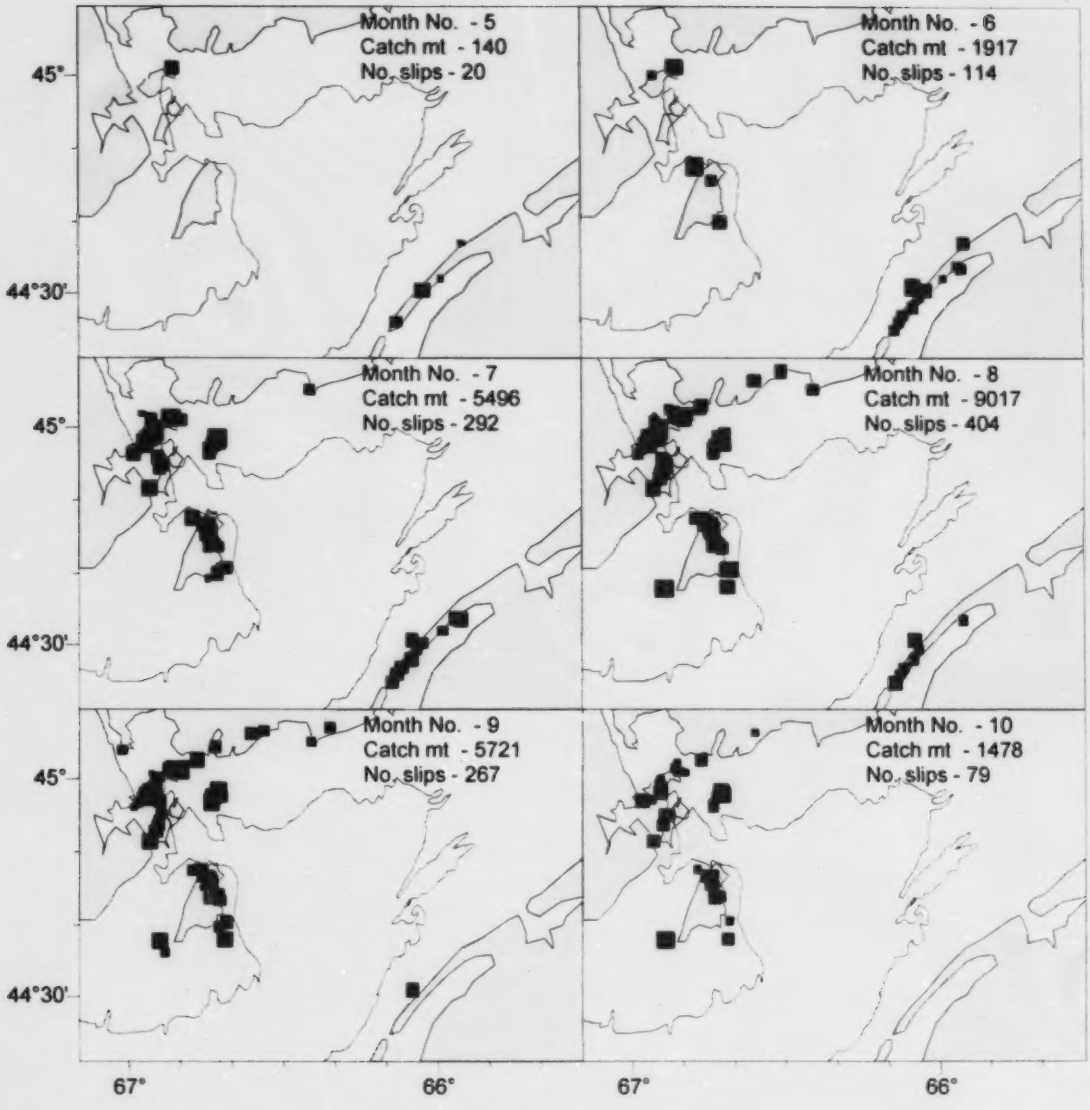

Figure 9. 2001 New Brunswick and Nova Scotia herring weir catches by month using exact weir locations.

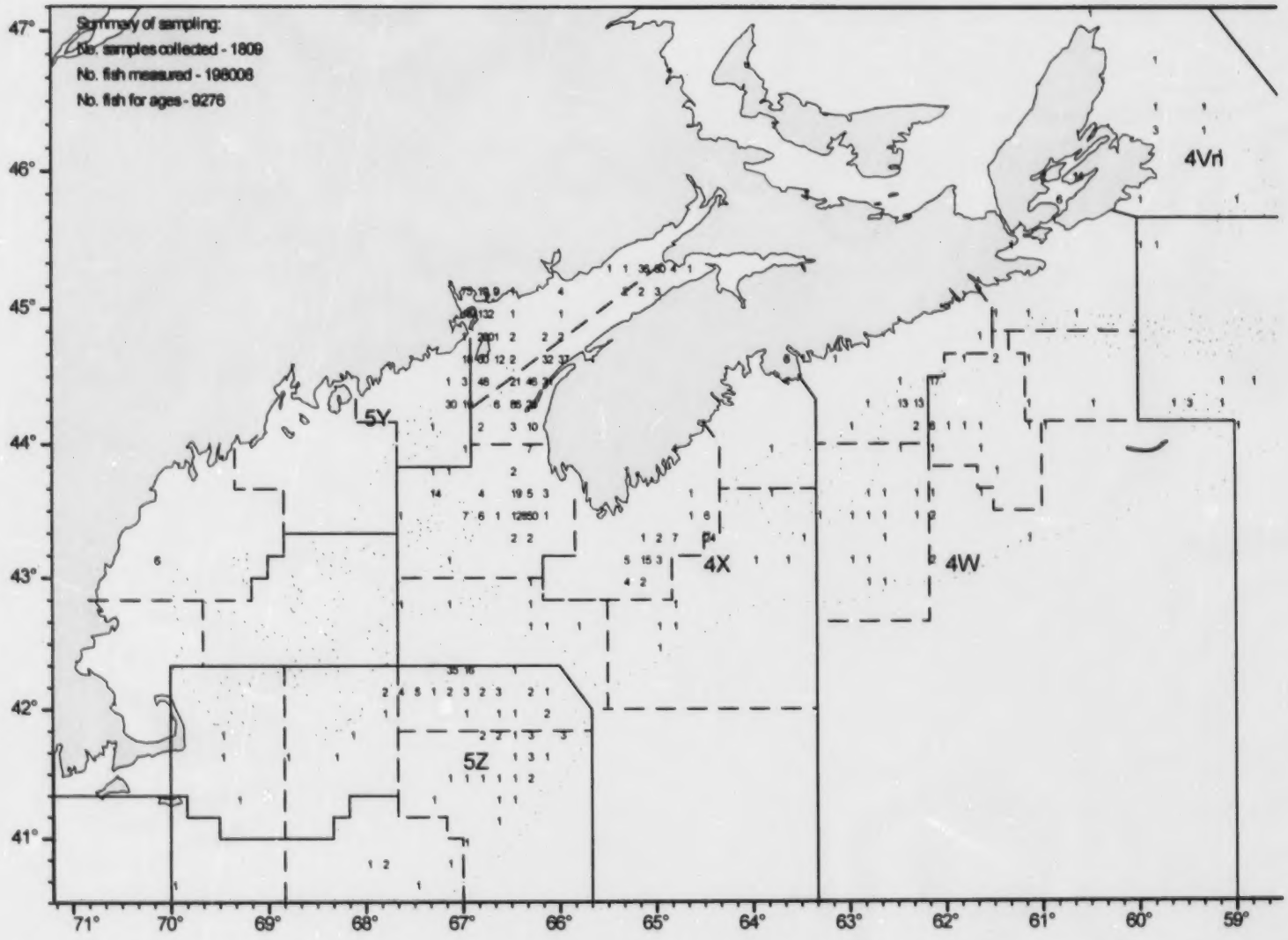

Figure 10. 2001 herring sampling coverage from all sources (number of length frequency samples by 10 mile square)

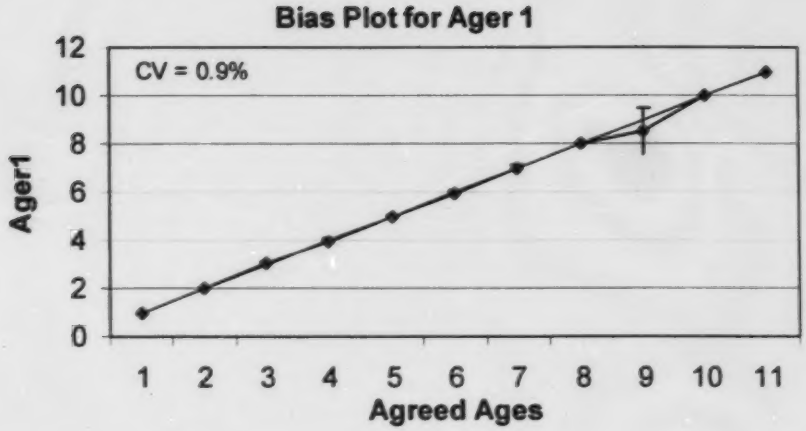

Figure 11. Age bias plot for Ager1 ages against Agreed Ages.

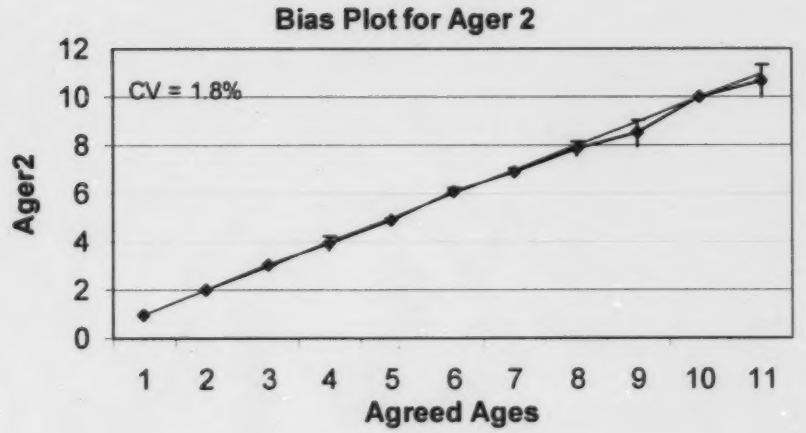

Figure 12. Age bias plot for Ager2 ages against Agreed Ages.

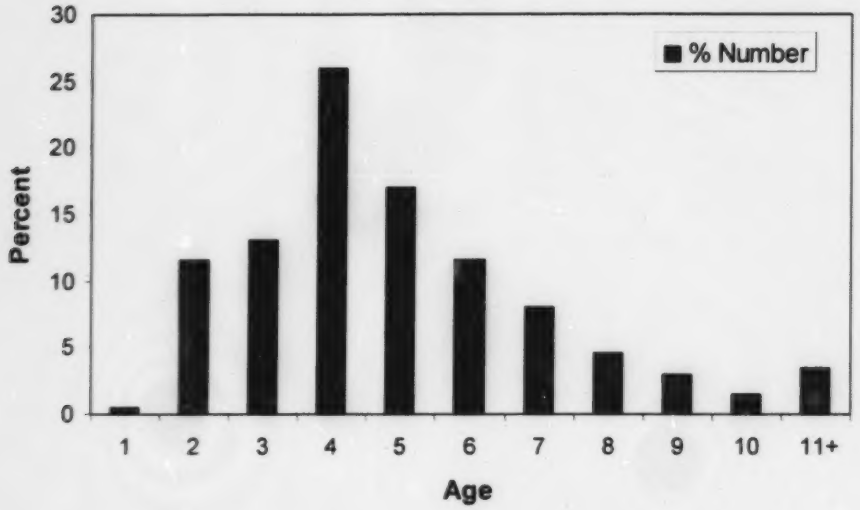

Figure 13. Expected age structure of SW Nova Scotia herring with fishing at $F_{0.1}$ and constant average recruitment. (Parameters: long-term F=0.23, annual recruitment=1.8 billion, natural mortality=0.2, partial recruitment vector=0.006, 0.235, 0.339, 1,1,1,1,1,1,1).

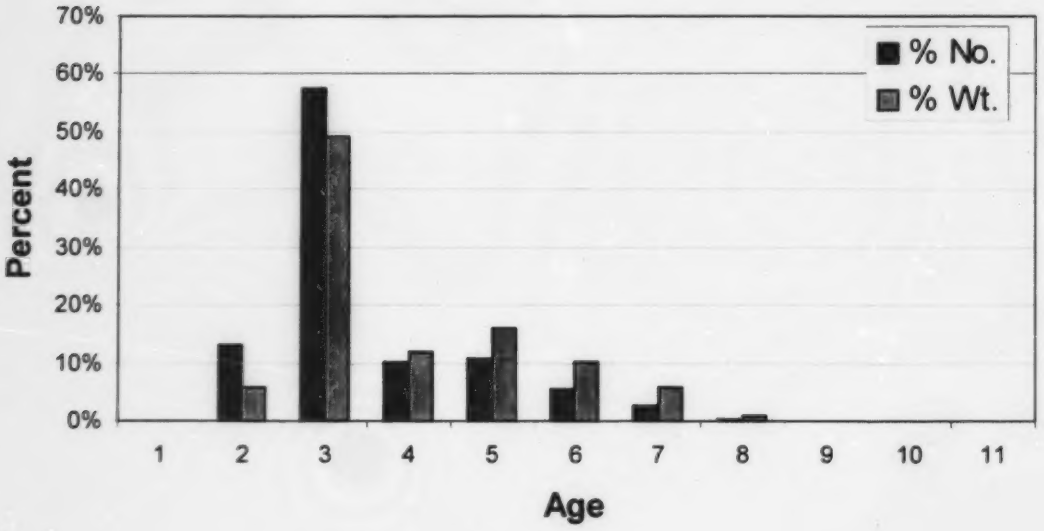

Figure 14. Catch at age for 2001 for the overall southwest Nova Scotia spawning component (% numbers and % weight).

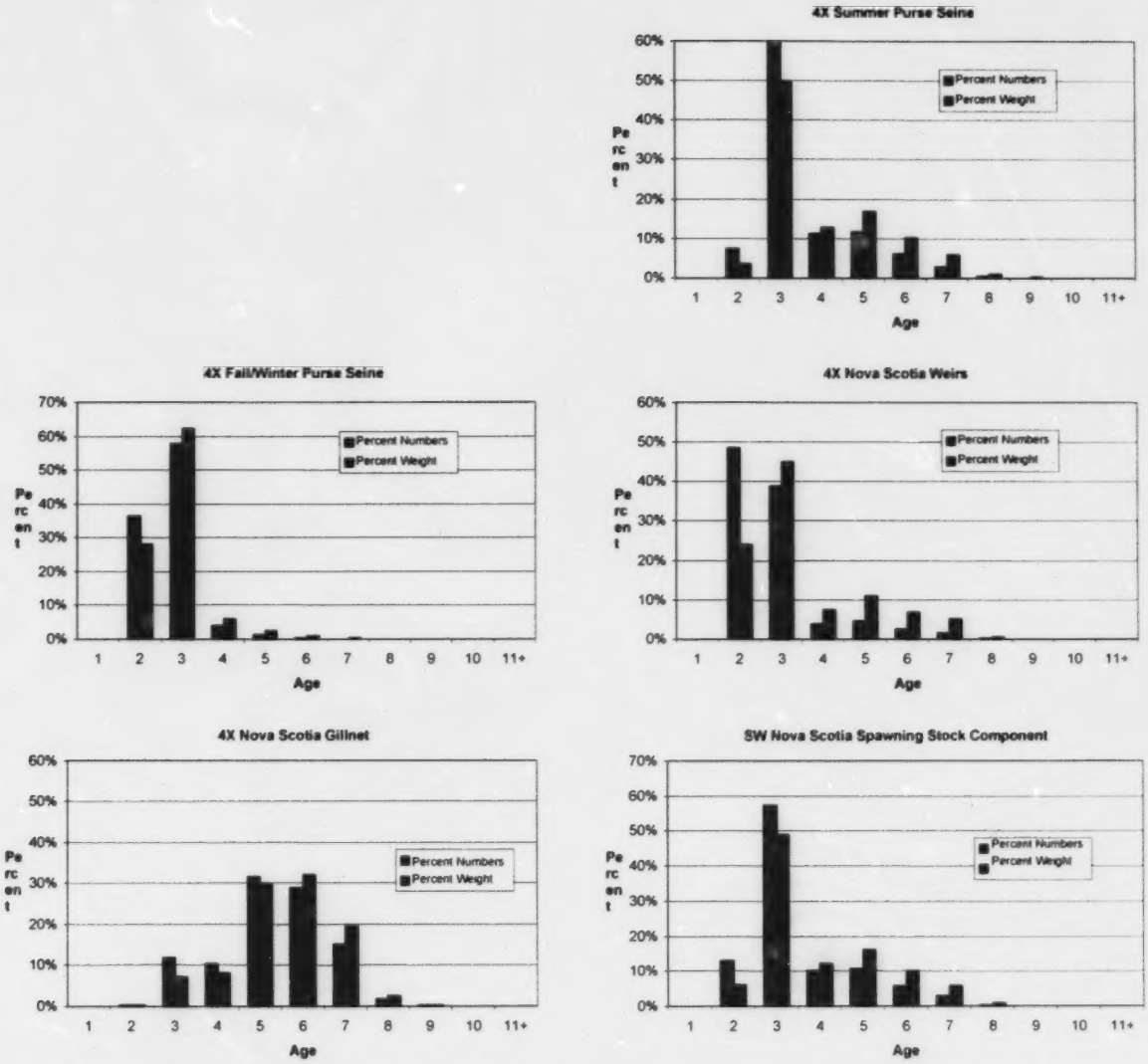

Figure 15. Catch at age for 2001 for the southwest Nova Scotia spawning component (% numbers and % weight) by gear type and for overall combined.

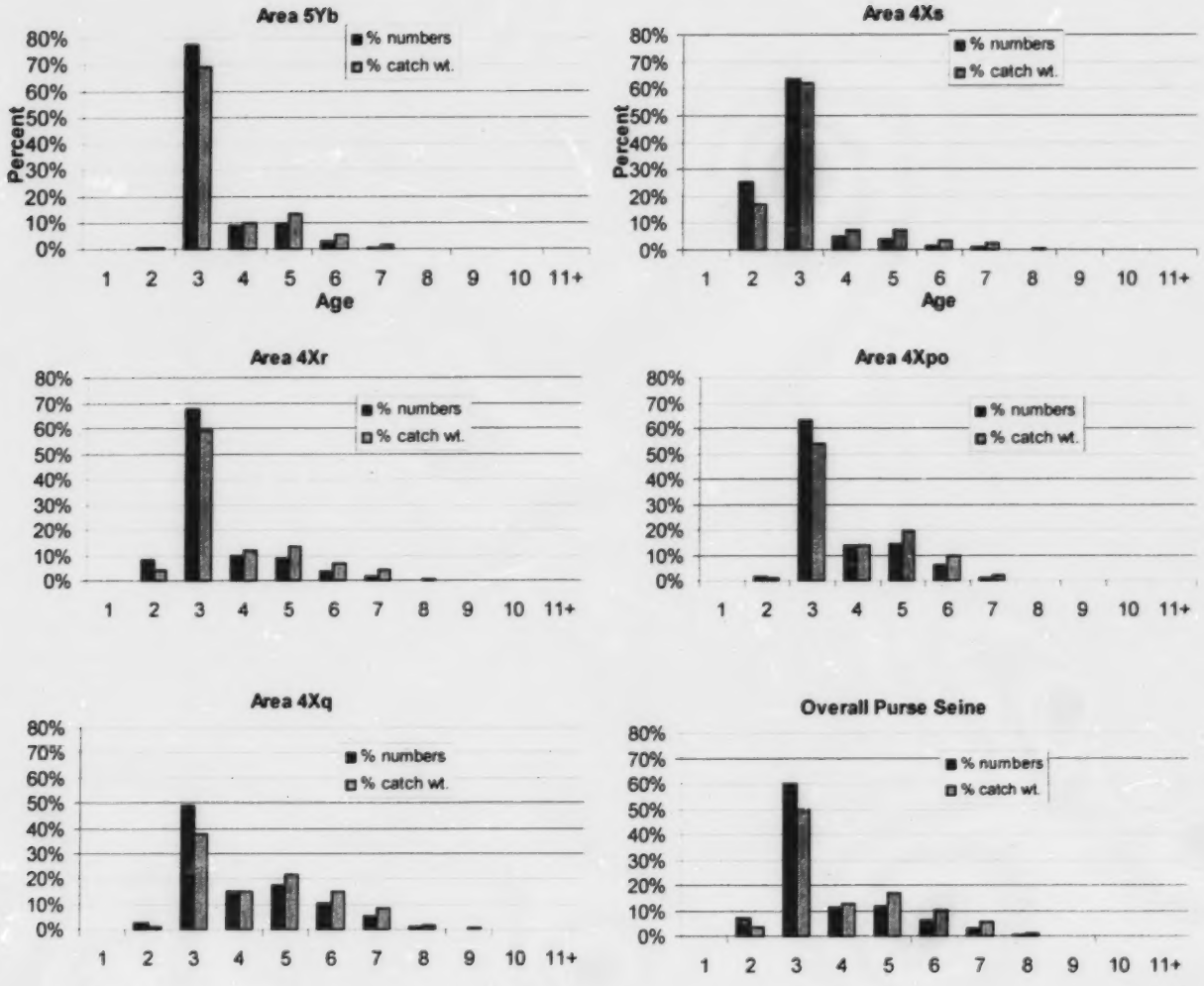

Figure 16.Herring catch at age by NAFO unit area for the 2001 summer purse seine fishery conducted on the southwest Nova Scotia spawning component (4WX stock).

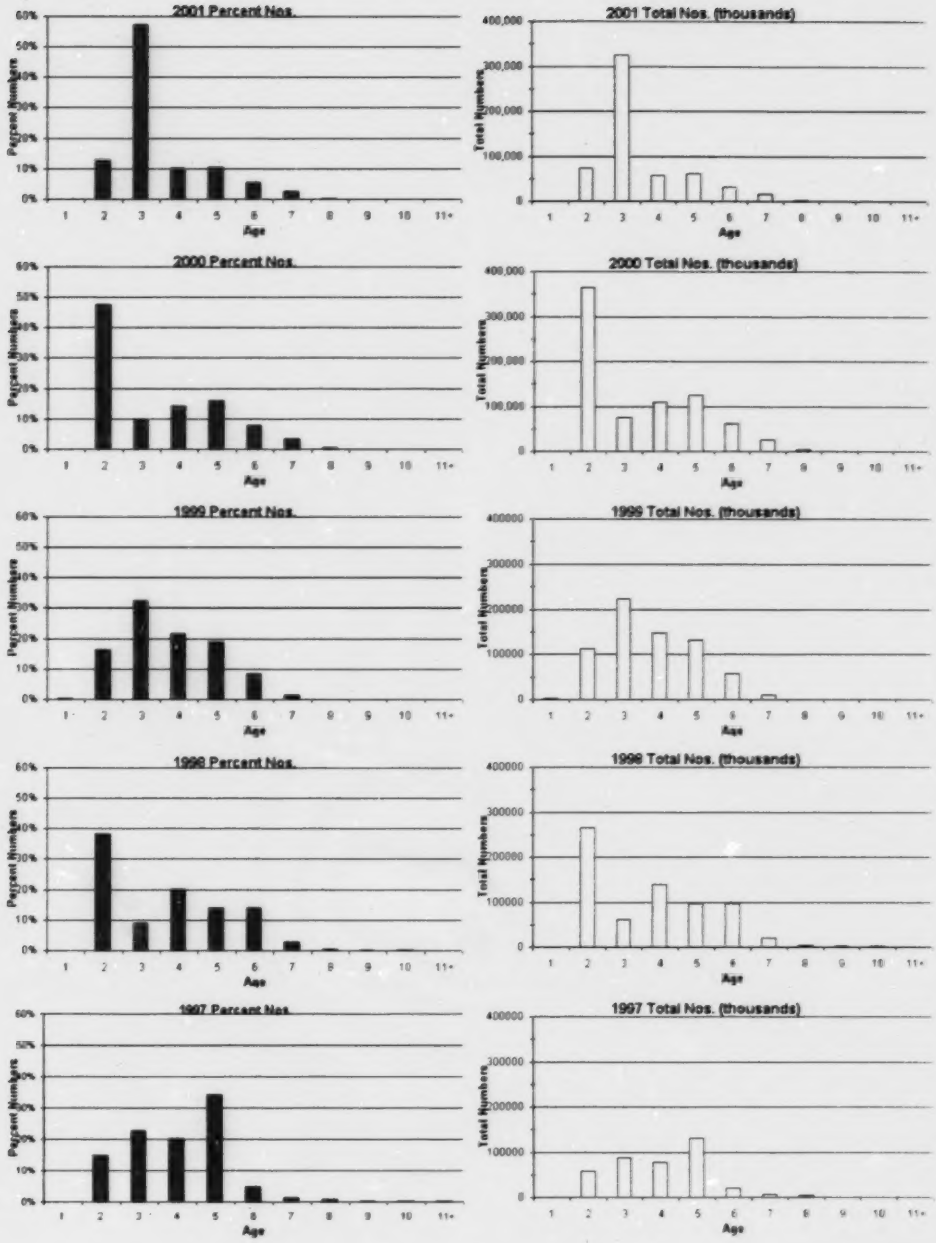

Figure 17. Catch at age (% numbers and total catch numbers in thousands) for the southwest Nova Scotia spawning component (4WX stock) from 1997 to 2001.

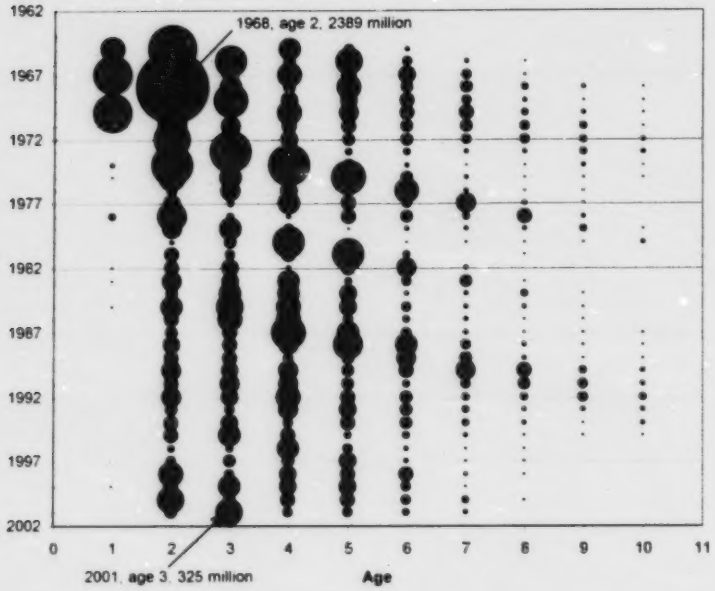

Figure 18. Historic catch at age (numbers in millions) for the SW Nova Scotia spawning component. Refer to Table 13 for actual numbers represented by symbol size. The value for 1968 at age 2 represents the maximum in the series.

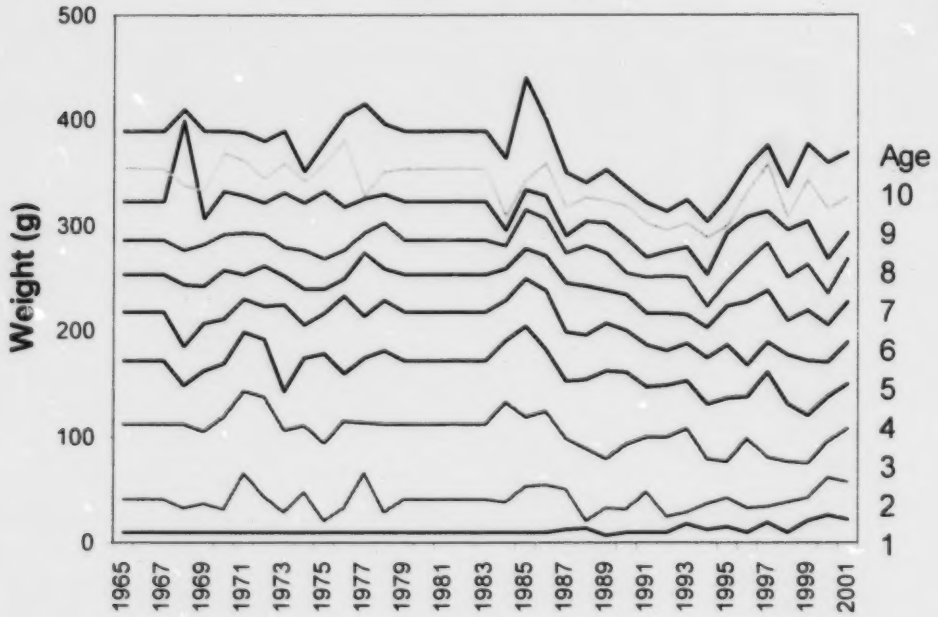

Figure 19. Average weights at age (g) for the SW Nova Scotia component of the 4WX herring fishery (weighted by fishery) for 1965-2001.

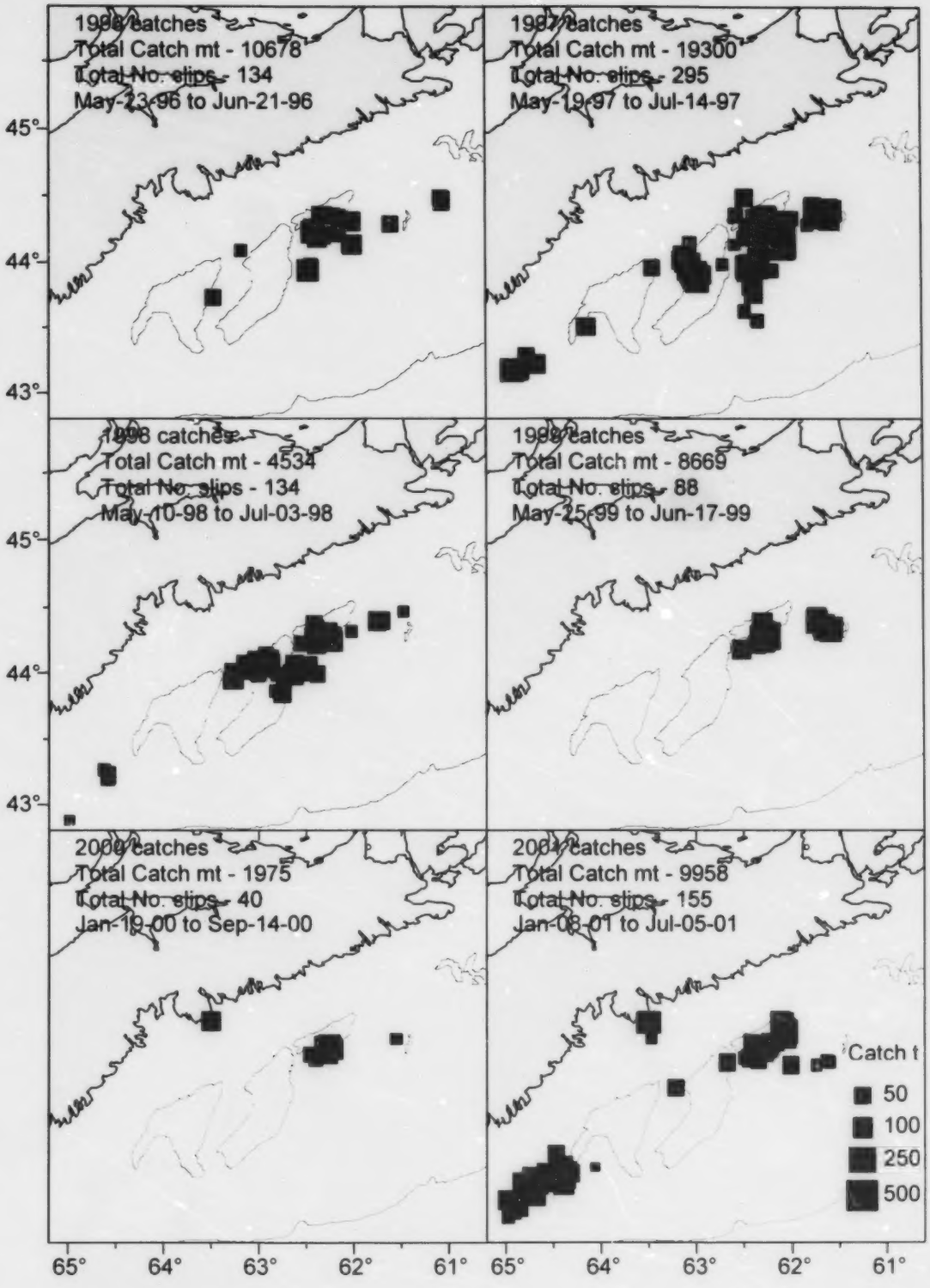

Figure 20. Herring purse seine catches (t) on offshore Scotian Shelf banks, 1996 to 2001.

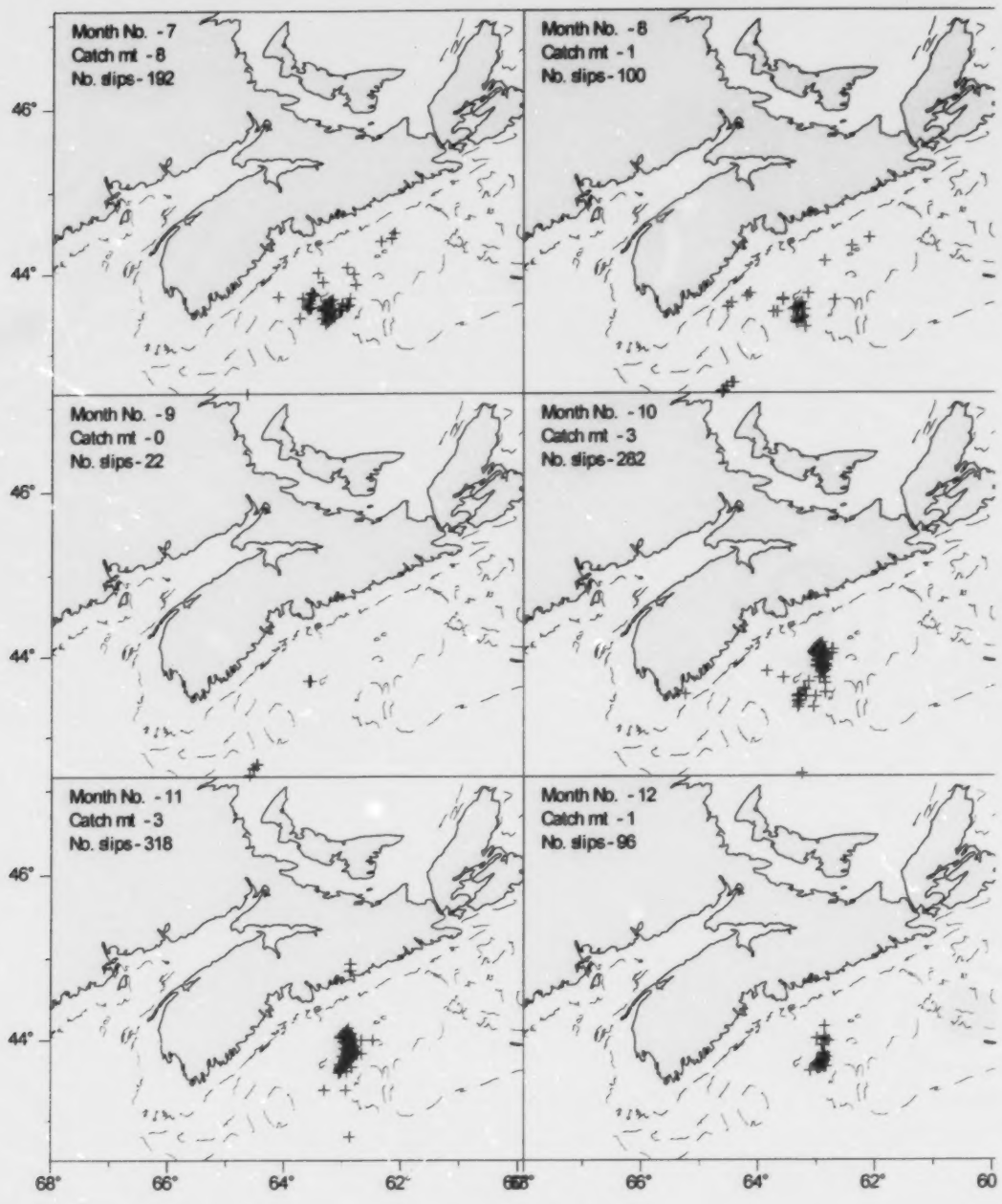

Figure 21. 2001 bottom trawl by-catch of herring (t) for NAFO areas 4VWX by month (data from Statistics Division ZIF database).

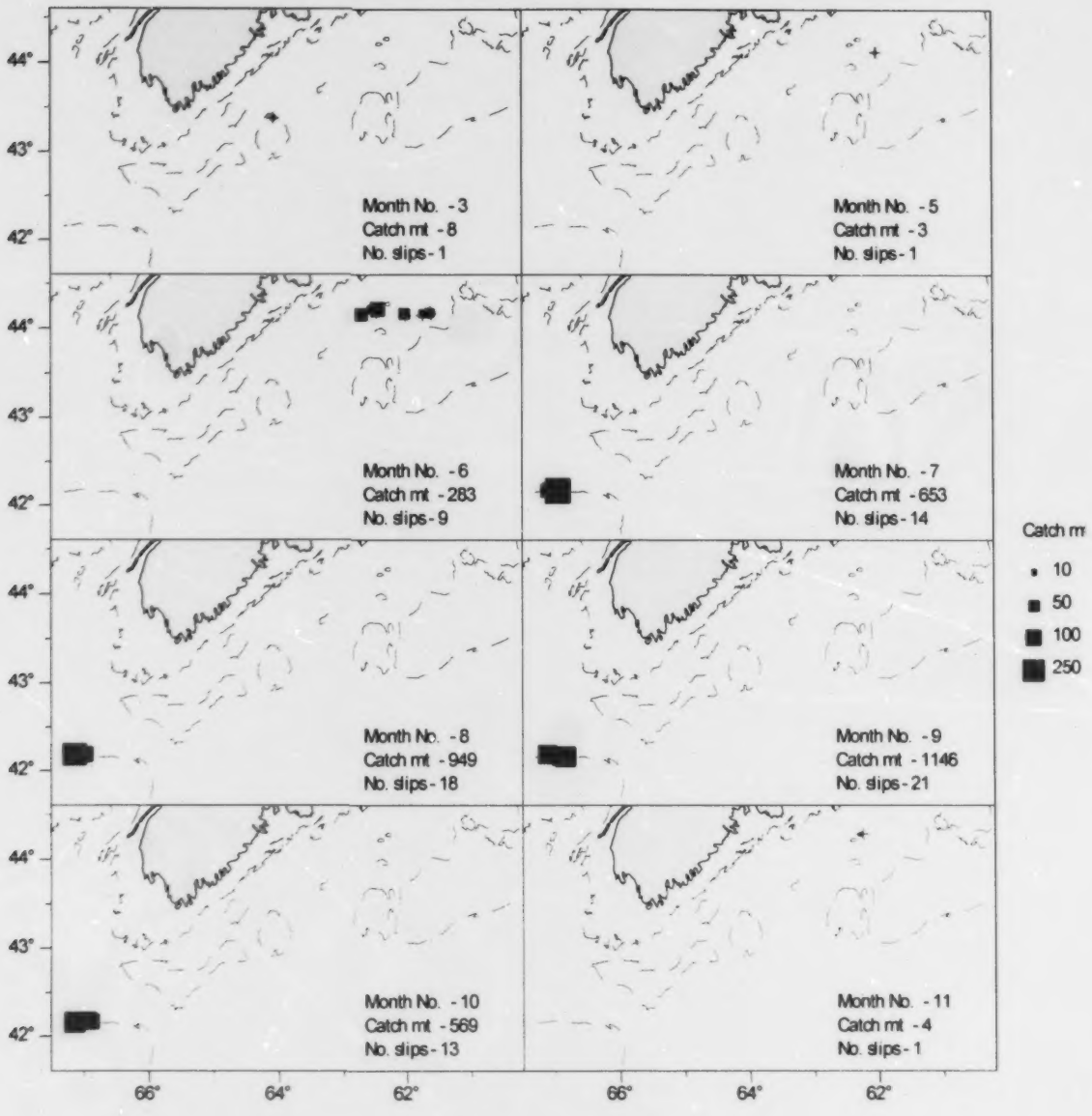

Figure 22. 2001 midwater trawl herring catches (t) for NAFO areas 4VWX by month (data from Statistics Division ZIF database).

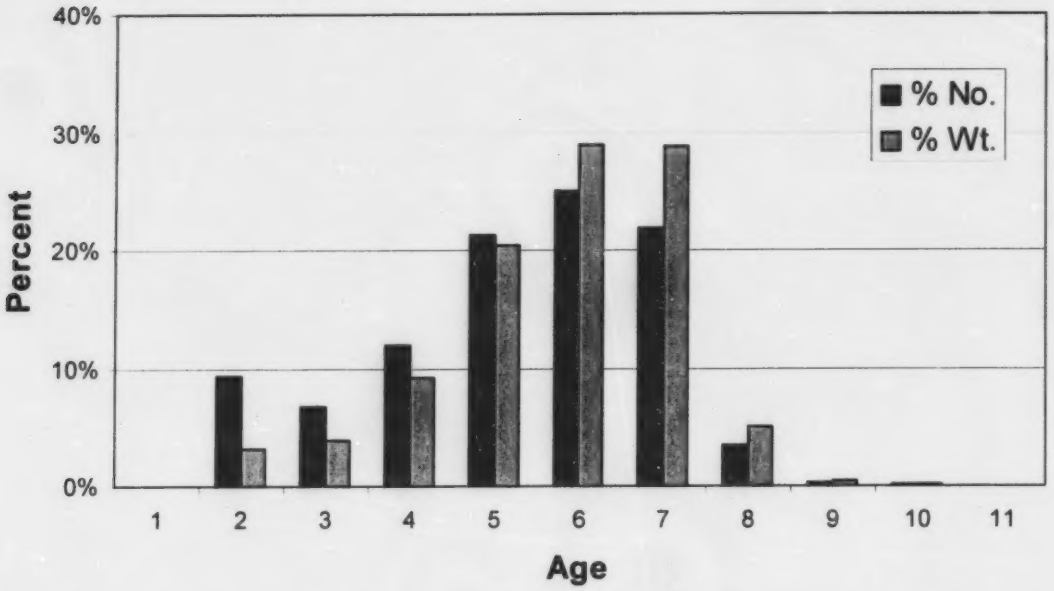

Figure 23. Catch at age for herring for the offshore Scotian Shelf Banks spawning component from the 2000 purse seine fishery.

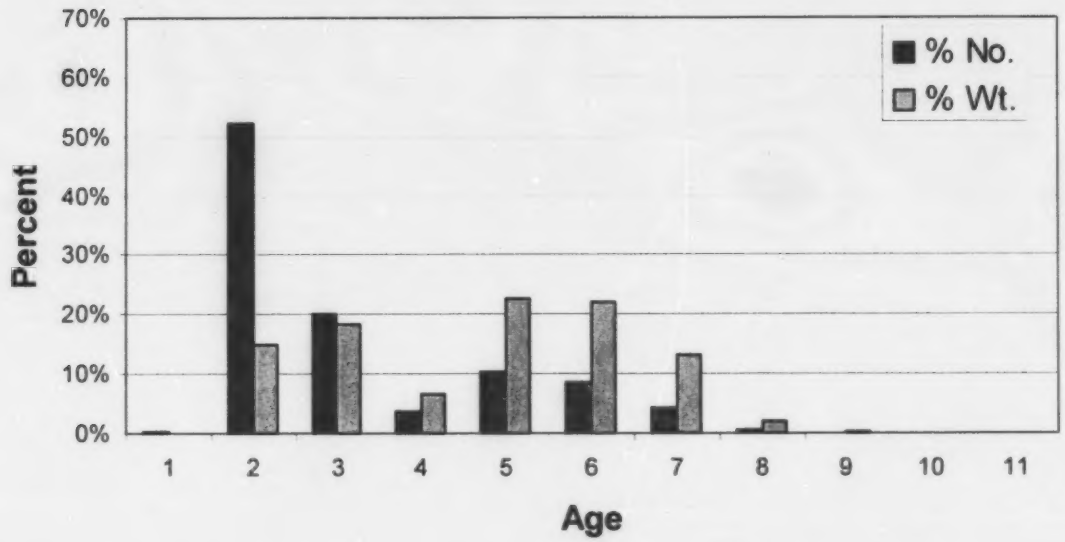

Figure 24. Catch at age for herring for the offshore Scotian Shelf Banks spawning component from the 2001 purse seine fishery.

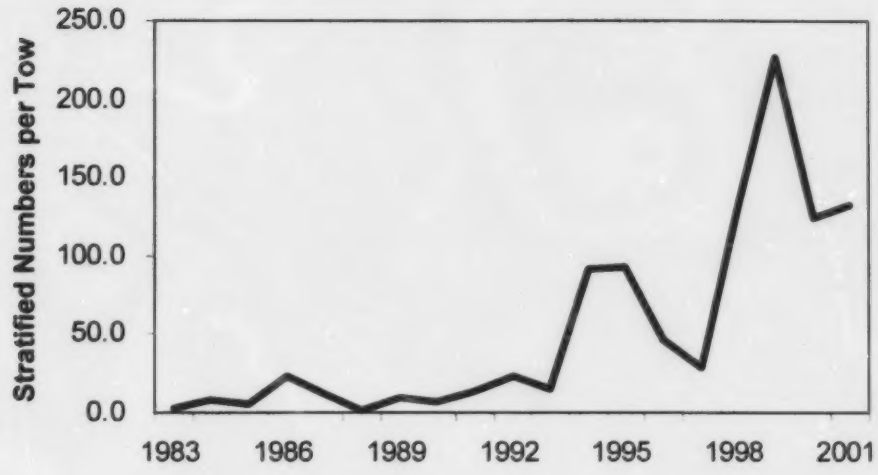

Figure 25. Number of herring caught per standard tow in the July bottom trawl survey of the offshore Scotian Shelf Banks, 1983 to 2001 (strata 55-78).

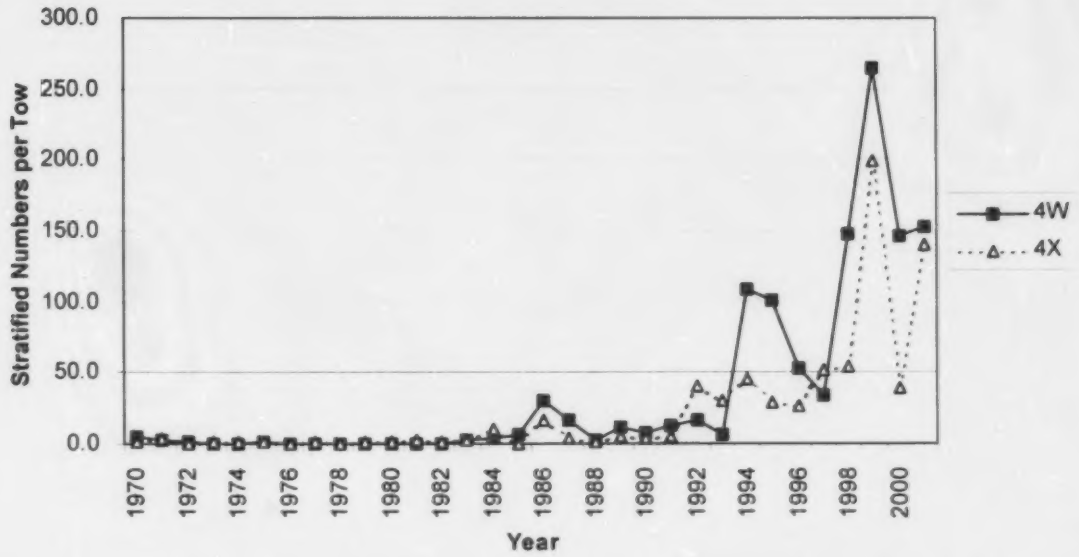

Figure 26. Number of herring caught per standard tow in the July bottom trawl survey of the offshore Scotian Shelf Banks, 1970 to 2001 for area 4W (strata 53-66) and area 4X (strata 70-95).

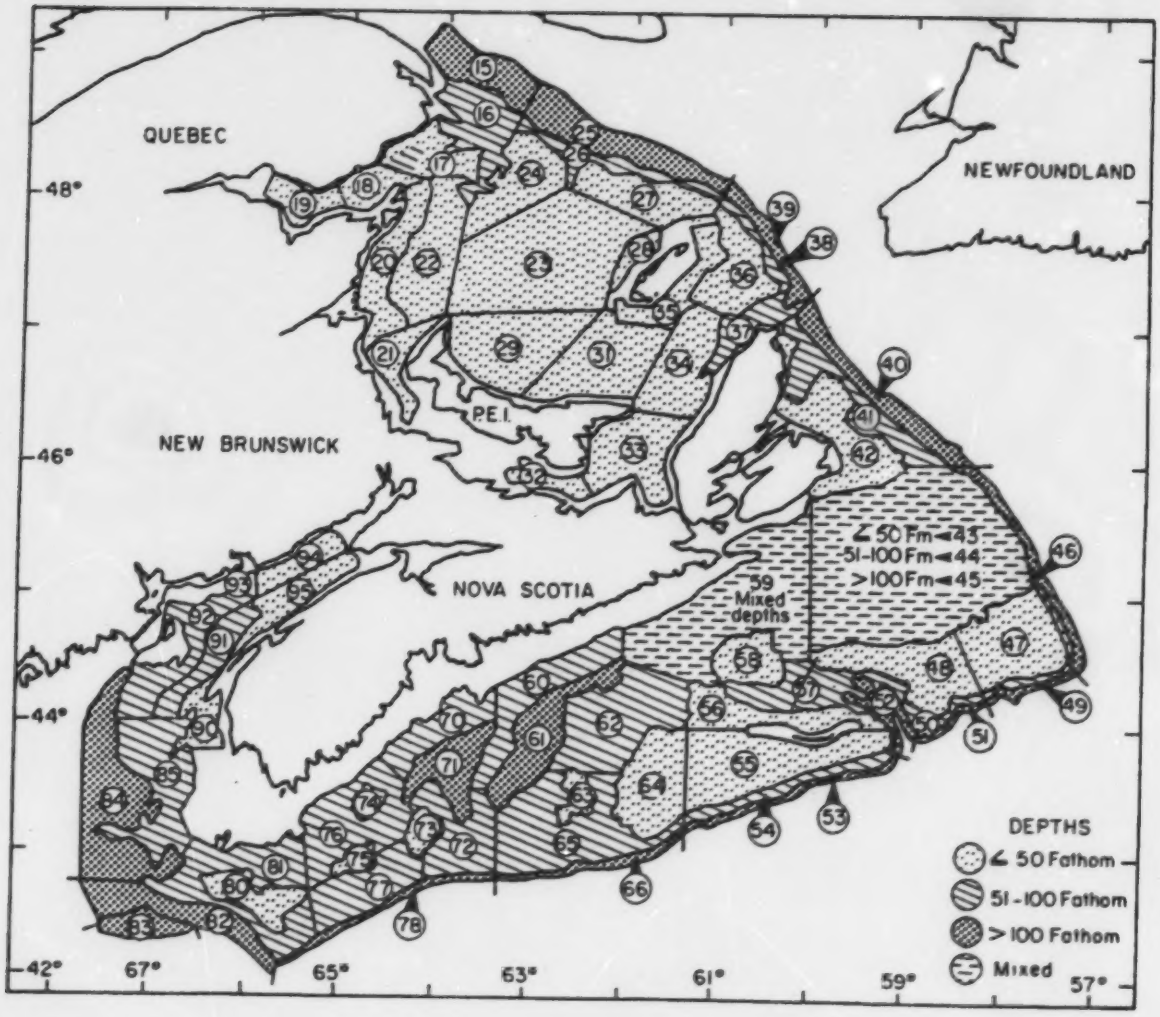

Figure 27. Groundfish survey strata in NAFO Divisions 4T, 4V, 4W and 4X (from Doubleday 1981).

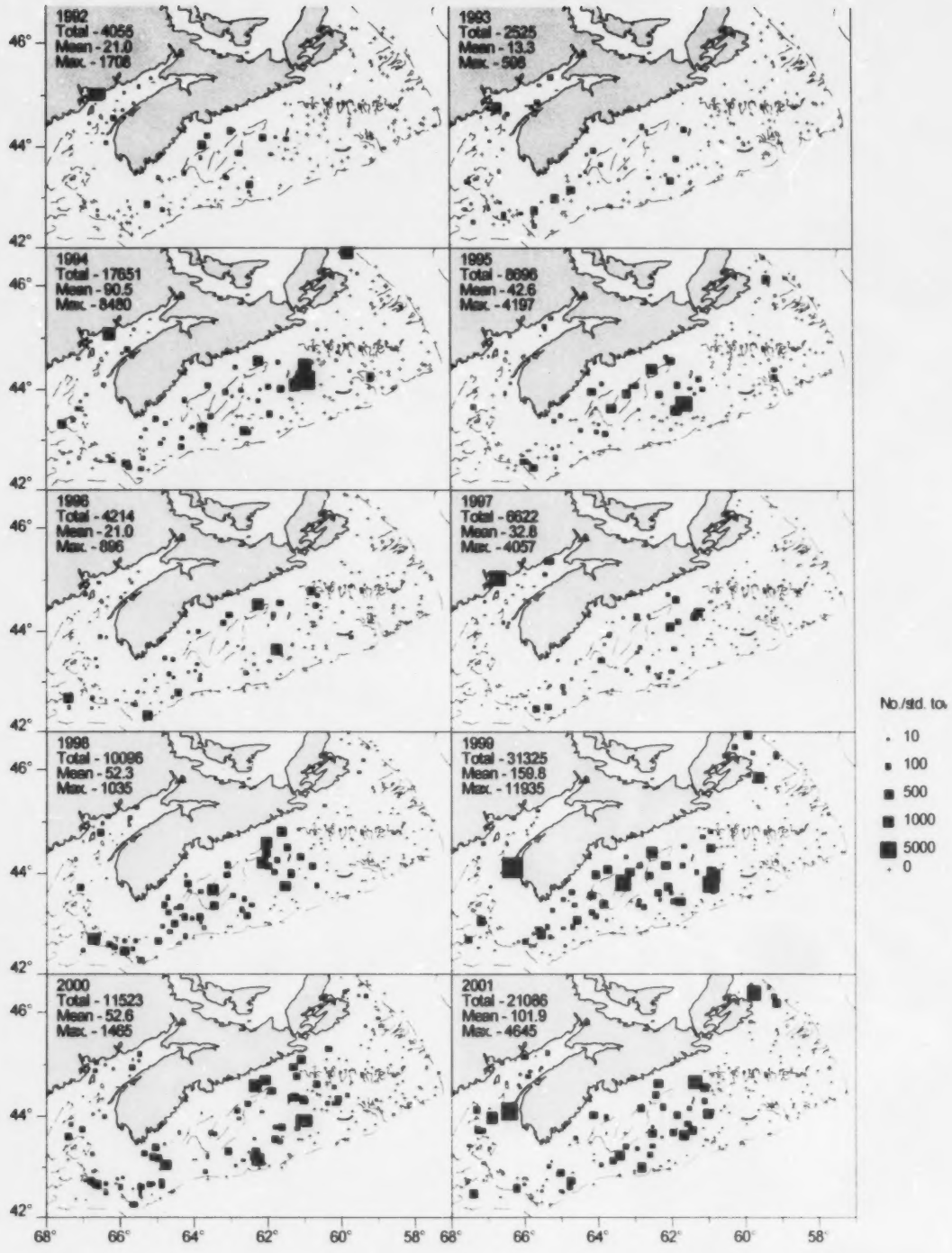

Figure 28. Herring catches (numbers per standard tow) from the July bottom trawl survey for 1992-2001.

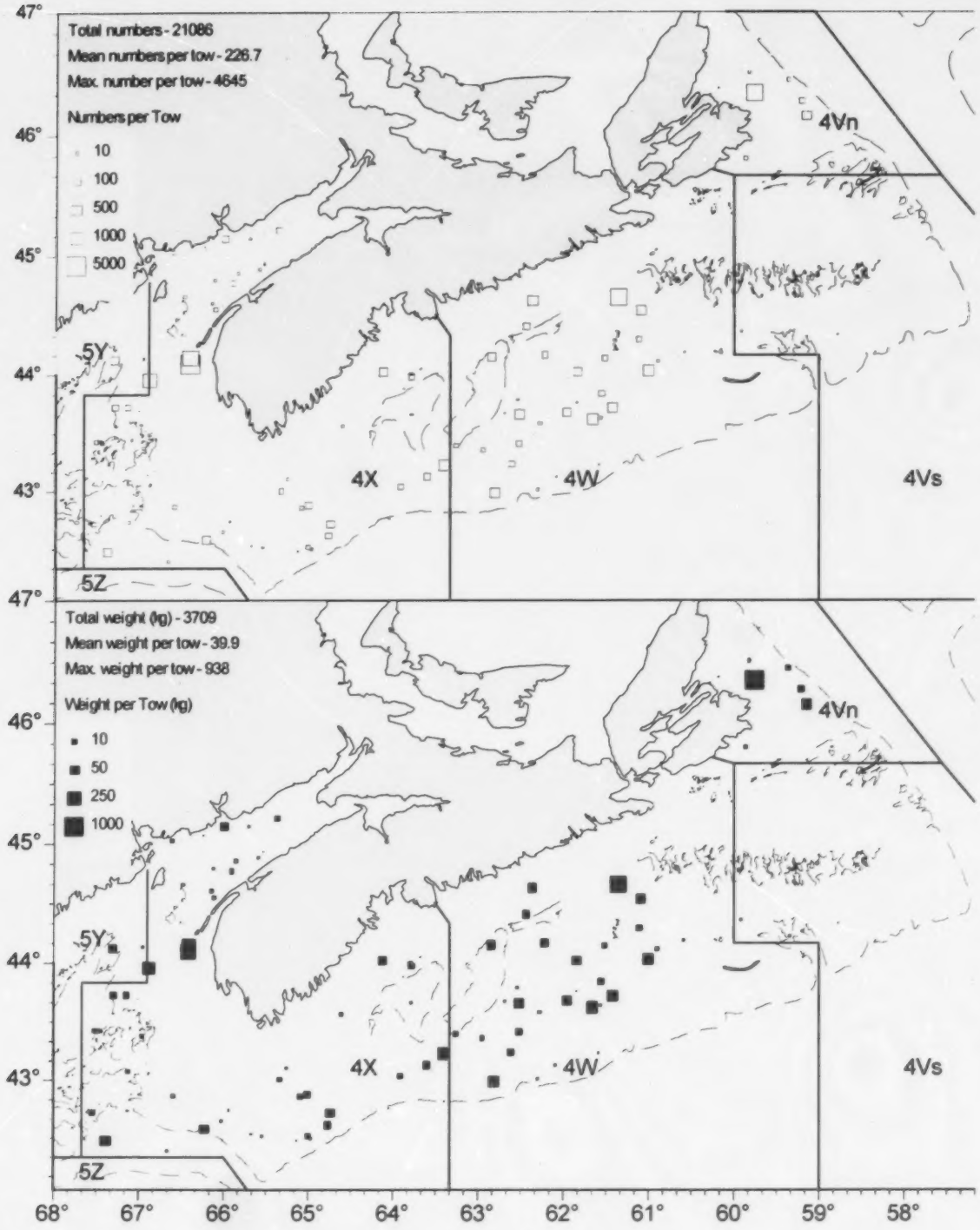

Figure 29. Herring catches (numbers per standard tow) from the July bottom trawl survey for 2001.

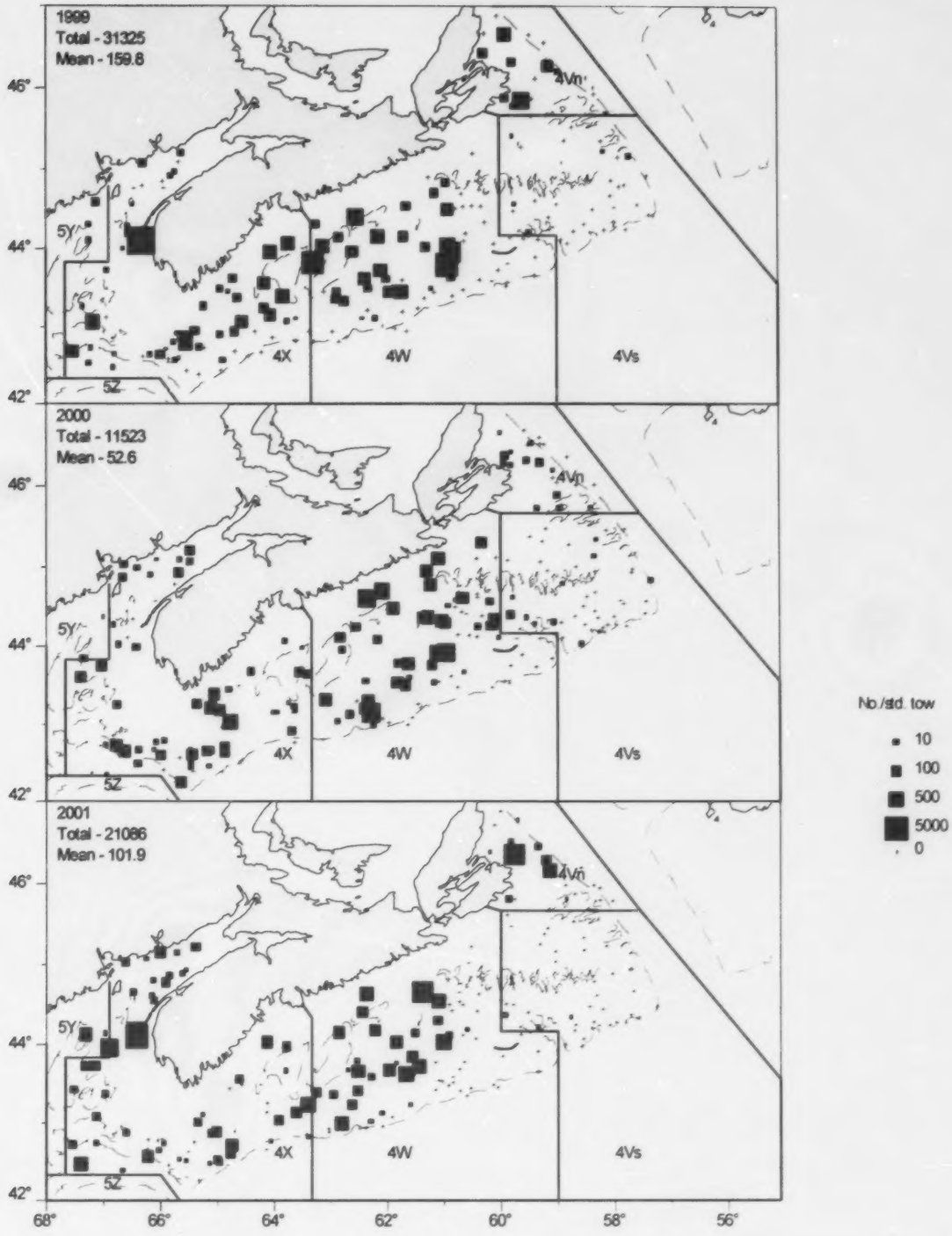

Figure 30. Herring catches (numbers per standard tow) from the July bottom trawl survey for 1999-2001.

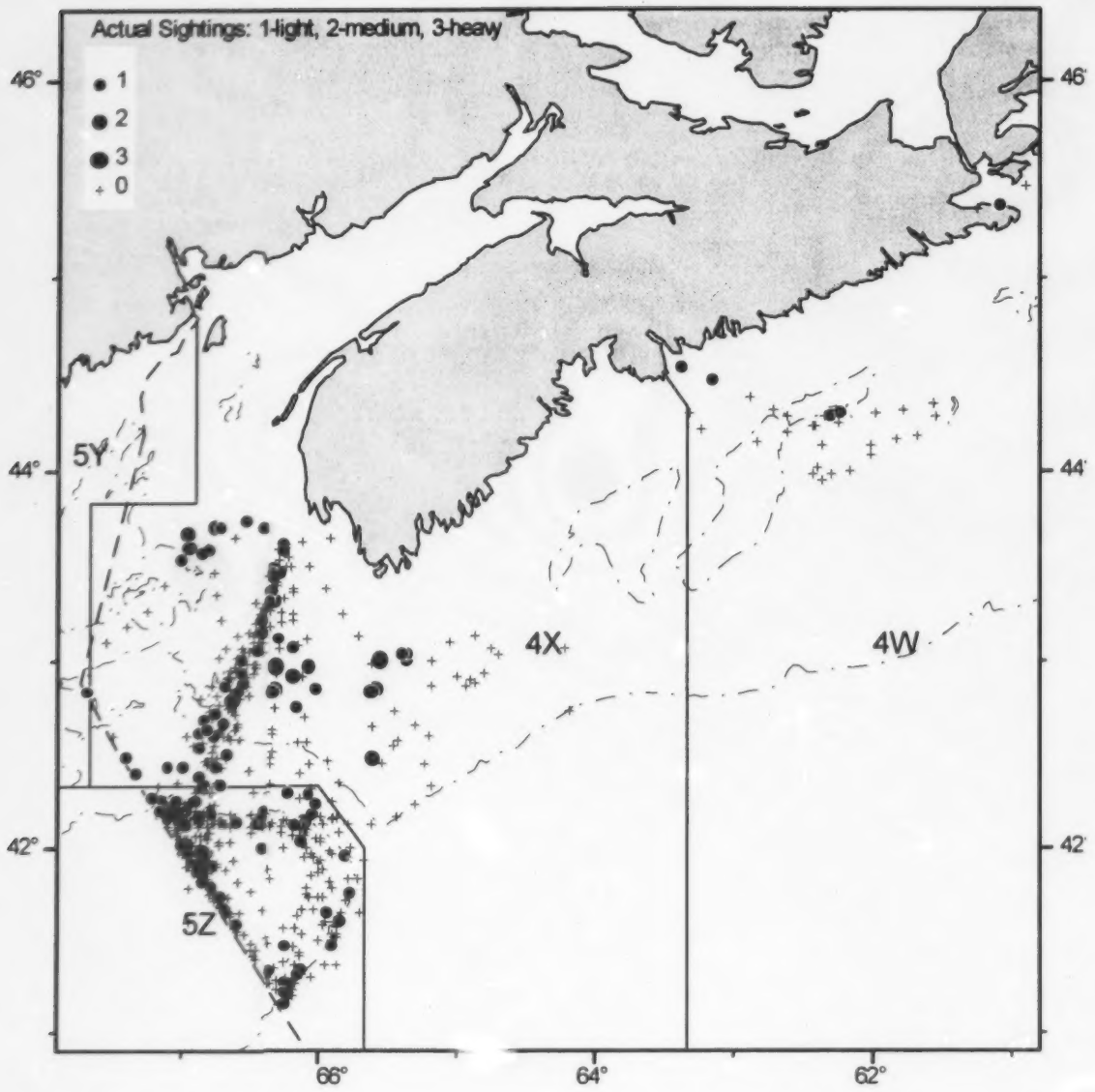

Figure 31. Herring midwater trawler (Morning Star) observations on southwest Nova Scotia, Georges Bank and the offshore Scotian Shelf banks for year 2001.

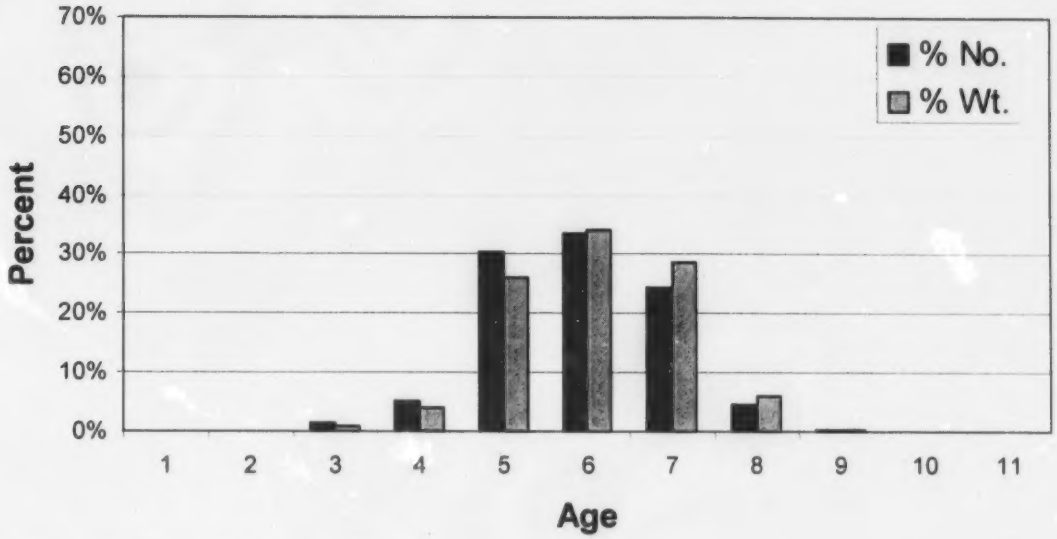

Figure 32. Catch at age (% numbers and % weight) of herring from the fall 2001 Port Mouton/Little Hope gillnet fishery.

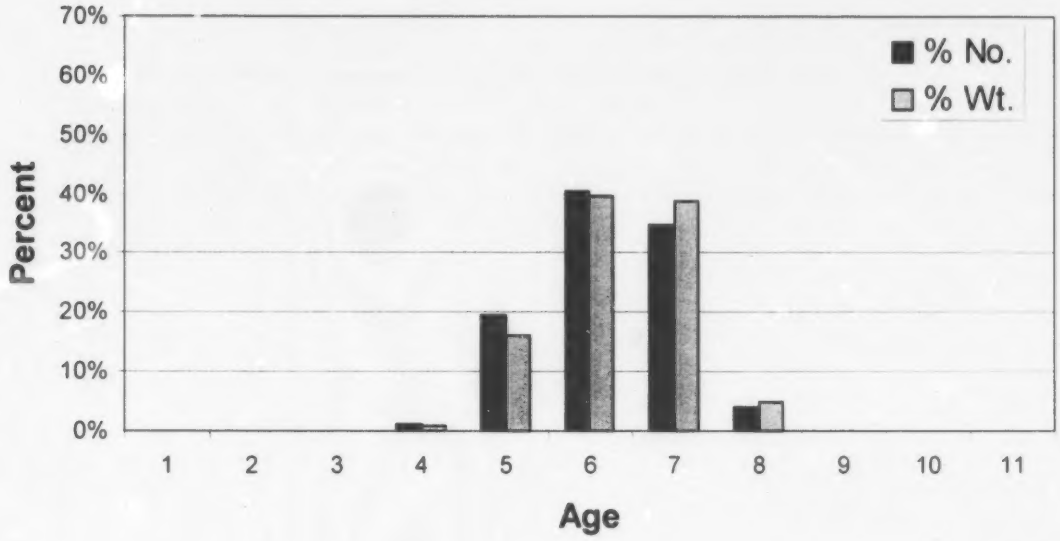

Figure 33. Herring catch at age (% numbers and % weight) for the fall 2001 gillnet fishery east of Halifax.

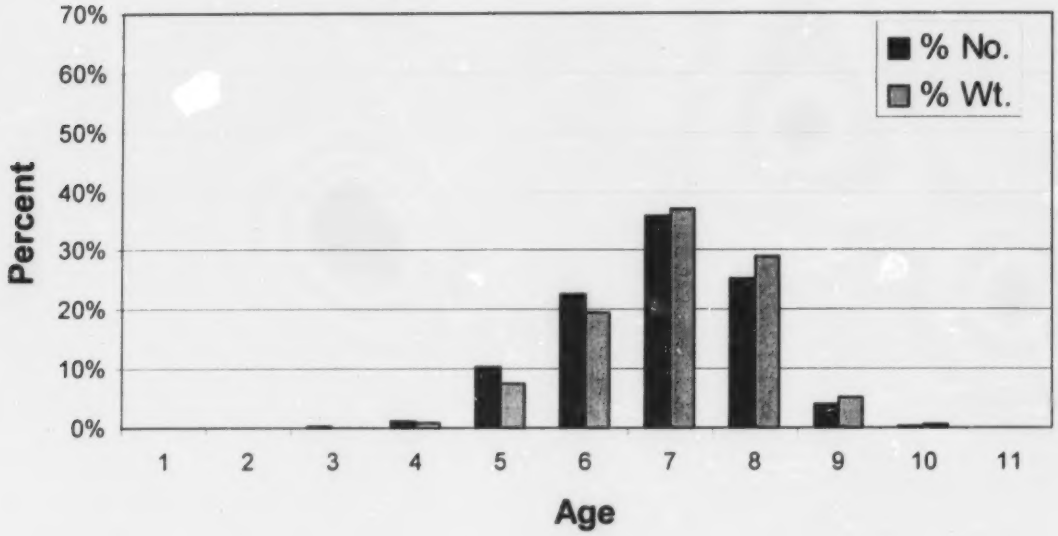

Figure 34. Catch at age (% numbers and % weight) of herring from the fall 2001 Glace Bay gillnet fishery.

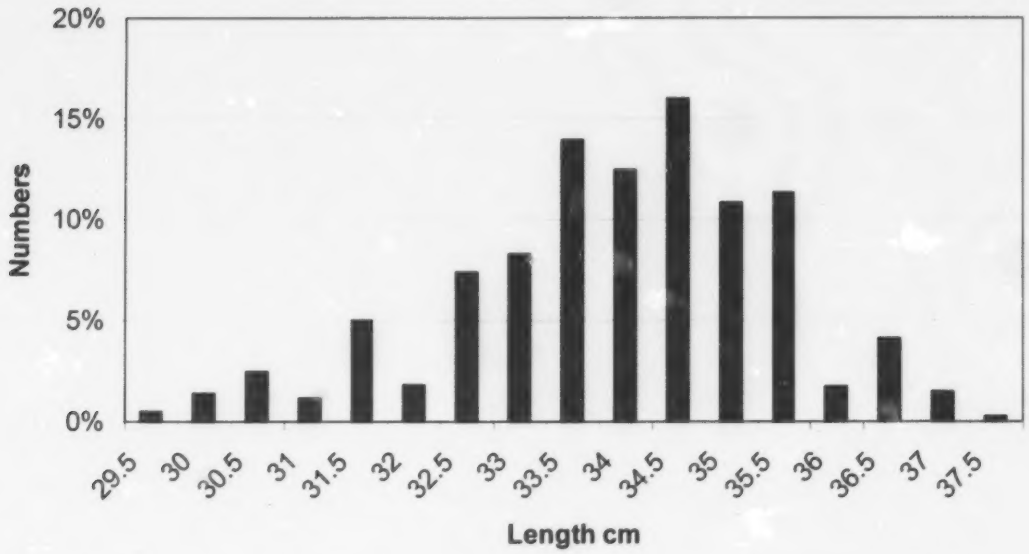

Figure 35. Catch at length (% catch numbers) of herring from the 2001 Bras D'Or Lakes spring gillnet fishery.

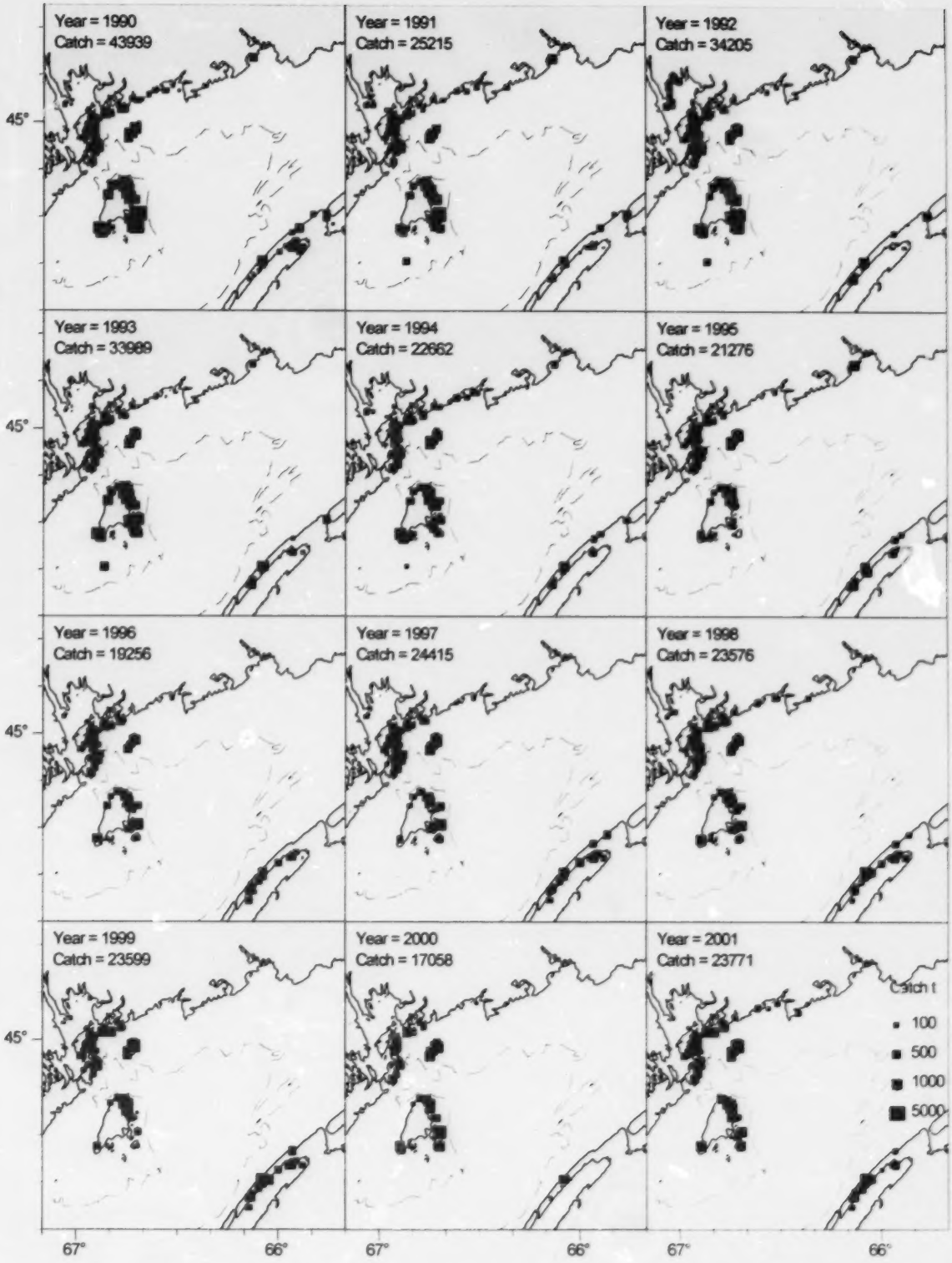

Figure 36. 1990-2001 New Brunswick and Nova Scotia herring weir catches (data summed by 1 mile square).

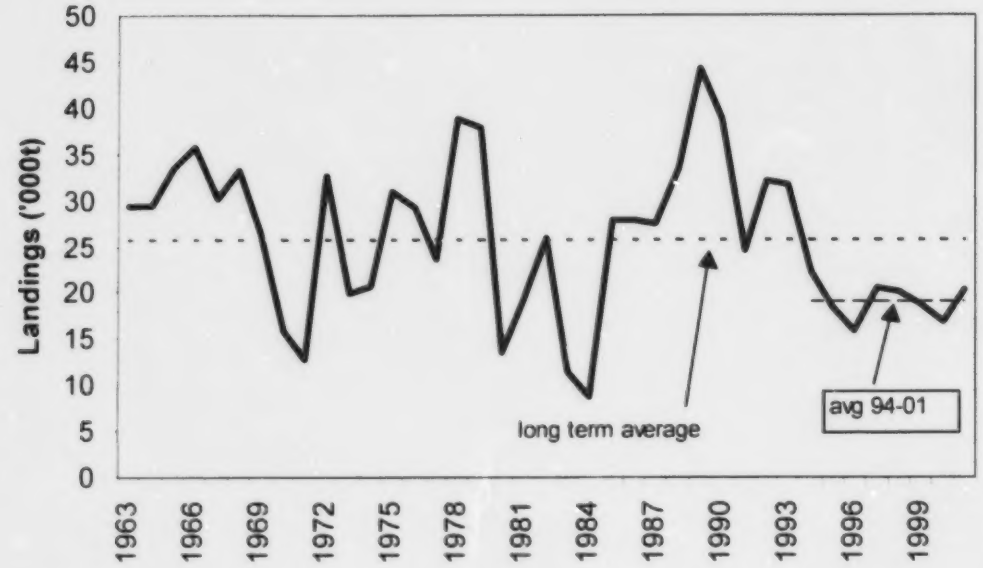

Figure 37. Herring landings from the southwest New Brunswick weir and shutoff fishery, 1963-2001.

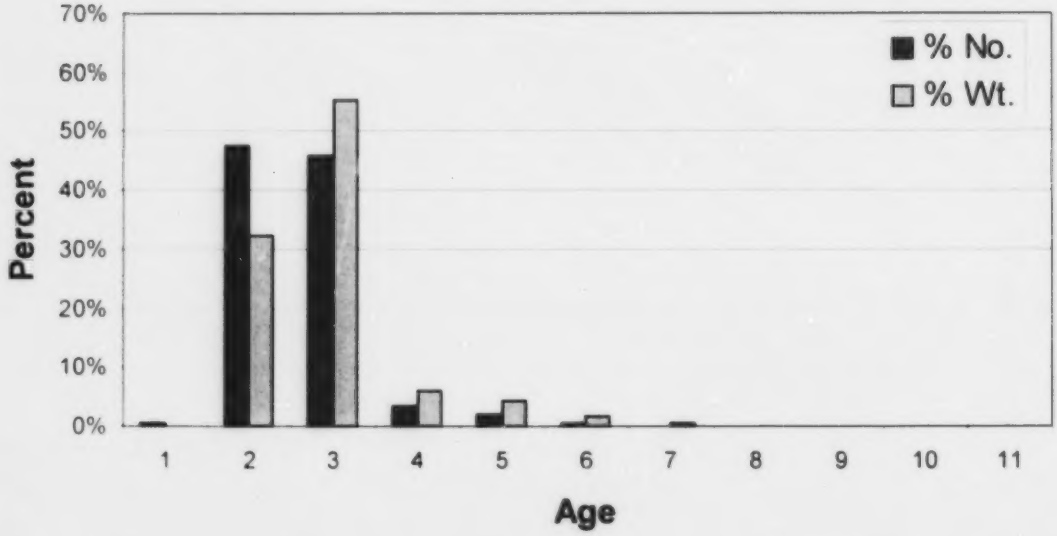

Figure 38. Catch at age (% numbers and % weight) of herring from the 2001 southwest New Brunswick weir and shutoff fisheries

Appendix A. 2001 4WX Herring Fishery: Seiner Fleet Activity

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The herring industry in association with Herring Science Council provides an annual summary of the fleet activity throughout the fishing season. This gives a general overview of the activities of the purse seine fleet and highlights important anecdotal information that may otherwise be lost. The overall landings by fishing area and week are summarized in Table A-1 and Figure A-1. Sampling by NAFO unit area week is shown in Table A-2. The following is a summary of the activities for the 2000 to 2001 quota year purse seine fishery.

Offshore/ Scotian Shelf Banks

2001 Fishing Weeks

Week 17:April 22-28
Three seiners fished on the offshore banks. Two landings were made from the outer banks, four from Western Hole, and one from the SW Grounds. A total of 112t was caught in the two areas. One sample of herring was collected from the SW Grounds, and the mean length was found to be 14.9 cm.

Week 18: April 29- May 5
Five boats fished in Western Hole. Fishing took place over four nights. A total of 18 landings were made from Western Hole. Two of the vessels fished one night each on the outer banks. Fourteen hundred and five tonnes of herring was extracted from western hole this week. The mean length of herring sampled was 16.0 cm.

Week 19: May 6- May 12
Seven boats fished around the outer banks on and Western Hole areas this week. Fishing activity resulted in twenty-four landings and 1,030t. The mean length of herring sampled was 17.2 cm.

Week 20: May 13- May 19
Five boats spent time fishing Western Hole this week, making a total of nine landings. Another vessel fished for 6 nights in the outer banks. 218t was picked up from Western Hole.

Week 21: May 20- May26
One vessel fished in the outer banks over three nights. Two vessels made single landings during the week from Western Hole. A total of 103t was caught in this area.

Week 22: May 27- June 2
One vessel fished one night in outer banks but there was no catch.

Week 23: June 3- June 9
One vessel fished one night in outer banks with 101t of herring caught. Fish sampled had a mean length of 26.5 cm.

Week 24: June 10- June 16
Nine boats were fishing in the outer banks over six nights. A total of 38 landings were noted from the outer banks. Five boats making single landings in Western Hole were recorded during the same week with 3,452t of pure herring were landed this week. The mean length of fish was determined to be 29.1cm.

Week 25: June 17- June 13
Eleven boats fished in the outer banks over five days. A total of 38 landings were reported from the outer banks. Three boats fished in Western Hole over five days, making a total of ten landings. One of the vessels made one landing from the SW Grounds. Seiners caught 3,342t of herring this week. Herring sampled showed a mean length of 27.4 cm in Western Hole, 27.8 cm in the banks west of sable, 28.7 cm in the banks southwest of Sable, and 29.0 cm in the Eastern Shore / Patch area.

Week 26: June 24- June 30
Nine boats fished in the outer banks, over three nights. A total of 29 landings were made with 1,553t of herring was landed. Mean fish length sampled from banks west of Sable was 30.0 cm.

Week 27: July 1- July 7
Five boats fished the outer banks the night of July 5, making five landings with 268t landed. One sample of herring was taken with a mean length of 28.2 cm.

Week 28: July 8-14
Two boats fished for one night on the SW Grounds, making two landings of 29t.

South West Nova Scotia Component

The quota year is from the period Oct. 15 to the following Oct. 14 and so catches from Oct. 15 to Dec. 31, 2000 are included in the quota total. The 2000 year fishing weeks are summarized separately below.

2000 Fishing Weeks

Week 42: October 15-October 21
Nine boats fished the Grand Manan Banks this week, over four nights. A total of 20 landings were made from Grand Manan, for a total of 864t. Three boats fished

the Long Island Shore over three nights for a total of five landings and there were also 1,970t of herring fished from German Bank this week.

Week 43: October 22- October 28
Six vessels fished in the Grand Manan Banks this week, with the activity taking place over five nights. A total of 14 landings were noted from this area. Two of the five boats also fished the Long Island Shore, accumulating 5 landings. One landing was recorded from a vessel fishing in Lurcher Shoal.

Week 44: October 29 – November 4

Week 45: November 5 – November 11
Five boats fished around Grand Manan over four nights this week, for a total of five landings. One landing was recorded from a vessel fishing in the Long Island Shore area.

Week 46: November 12 – November 18
Two boats fished off Grand Manan, one for one night and the other for two. This totaled three landings.

Week 47: November 19-November 25
One boat fished for six days off Grand Manan, and one boat fished one night off Grand Manan. A total of seven landings were made this week.

Week 48: November 26- December 2
One vessel fished off Grand Manan, making a total of two landings over a period of two days.

2001 Fishing Weeks

Week 20: May 6- May 12
At the start of the week, one vessel fished for three nights on the Gannet Dry Ledge, and then moved on to German Bank for one night.

Week 21: May 20- May 26
Six vessels fished the Long Island Shore (802t) over five fishing nights. Collectively, they made a total of 27 landings. Five boats made six landings on German Bank (116t), and two of the five moved to Gannet Dry Ledge (26t) for one landing each. Herring samples taken from 4Xr (NS side of Bay of Fundy) showed a mean length of 22.8 cm.

Week 22: May 27- June 2
Seven boats started out the week fishing on the Long Island Shore, making a total of seven landings accumulating 178t of herring. The boats then moved to Grand Manan banks, to give a total of nine boats on Grand Manan. The boats were able

to make 23 landings in Grand Manan, for a total of 664t. One of the vessels also made a landing on German Bank this week, procuring 106t. Length frequency samples for German Bank showed the mean length of 25.1cm, NS side of Bay of Fundy 21.7 cm, and NB side of Bay of Fundy 21.3 cm.

Week 23: June 3- June 9

Four boats started the week out fishing on the Long Island Shore, making six landings (94t). A total of seven boats ended up visiting the banks around Grand Manan. They were able to make 25 landings, producing 602t. Four vessels fished for herring at Gannet Dry Ledge (10 landings totaling 638t), and then moved on to German Bank (9 landings totaling 1,179t) during the latter part of the week. Two vessels fished four nights in German Bank. German Bank had a grand total of 17 landings for the week. Fish samples from German Bank had a mean length of 26.9 cm, NS side of Bay of Fundy were 23.5 cm, and NB side of Bay of Fundy were 22.0 cm.

Week 24: June 10 – June 16

Seven boats began fishing in Grand Manan. They made a total of 25 landings with 583t. Three boats made six landings from Long Island Shore during the middle of the week, with 132t. Two landings were made on German Bank with a total of 142t. This week samples taken from German Bank was 27.77 cm, NS side of Bay of Fundy was 23.4 cm, and 22.9 cm from the NB side of Bay of Fundy.

Week 25: June 17- June 23

Six boats fished solely on the banks around Grand Manan this week, with activity carried over five nights. The boats landed a total of 907t from 30 landings in Grand Manan. Samples taken from the NB side of Bay of Fundy had a mean length of 25.5 cm.

Week 26: June 24- June 30

Eight boats fished in Grand Manan over five days, making a total of 26 landings and 727t of herring. Two vessels moved on to Gannet Dry Ledge for three landings (160t) and one boat to German Bank to fish four nights (192t). Samples taken from the NB side of the Bay of Fundy had a mean length of 25.2 cm.

Week 27: July 1- July 7

Seven boats fished in Grand Manan over seven nights. A total of 26 landings were made and 839t of herring were caught from the banks around Grand Manan. Samples recovered from the NS and NB side of Bay of Fundy had mean lengths of 27.0 cm and 25.0 cm.

Week 28: July 8- July 14

Seven boats fished around Grand Manan, totaling 24 landings and 593t. Five boats moved to the Long Island Shore to make 14 landings and 569t. Fourteen boats fished in Scot's Bay during the week. Four boats fished there all week, while

the remainder moved into the area during the latter part of the week. The total number of landings in Scot's Bay was 34 and the total tonnage was 2,886t. Two boats fished German Bank in the beginning of the week, with a total of two landings (121t). Samples collected from the NS and NB side of the Bay of Fundy had mean length frequencies of 26.2 cm and 25.5 cm respectively.

Week 29: July 15- July 21

Seven boats fished in the Grand Manan and Long Island Shore over the week, with the majority starting in Long Island and finishing the week in Grand Manan. The total landings in Long Island were 27 (731t), with the total for Grand Manan at 10 (325t). Similar to the previous week, 14 boats fished in Scot's Bay for the entire week, with 50 landings for 3,460t. Length frequency samples for NS and NB sides of the Bay of Fundy were 25.9 cm and 25.0 cm. An industry/DFO survey of Scots Bay was initiated on the evening of July 16. Length frequencies for Scot's Bay showed modes at 28, 26, 30 and 32.5 cm. Length frequencies for Advocate Bay showed modes at 25.5, 29.0, 30.5 and 31.5 cm.

Week 30: July 22- July 28

A total of 19 vessels were actively fishing. Five vessels alternated between the Long Island Shore and Grand Manan Banks. Two vessels fished on Grand Manan for the duration of the week. Landings on Long Island Shore were 8 (144t) and landings on Grand Manan were 19 (554t). Six boats fished in Scot's Bay, making a total of 12 landings (885t). Eight vessels acquired fish at Pollock Point, bringing in 24 landings and 1,689t of herring. Two landings were made at Gannet Dry Ledge this week (155t). Samples taken from German Bank had a mean length of 28.3 cm. NS and NB sides of the Bay of Fundy had samples taken which showed mean lengths of 26.3 cm and 26.1cm.

Week 31: July 29- August 4

This week 19 herring seiners were actively fishing. Landings were broken up over the week between the various fishing areas: Grand Manan (18 landings and 440t), Long Island Shore (5 landings and 109t), and Gannet Dry Ledge (18 landings and 1,281t). Also fished were Scot's Bay (13 landings and 733t), German Bank (2 landings and 96t), and Lurcher (4 landings and 205t). Mean length of fish found on German Bank was 26.2 cm. Samples collected on the NS side of the Bay of Fundy had a mean length of 26.6 cm. An industry/DFO-sponsored survey of Scot's Bay was completed on July 31.

Week 32: August 5- August 11

Twenty vessels fished for herring. Ten boats fished in Long Island making a total of 30 landings and landing 849t of herring. Eleven boats fished in Scot's Bay, making 33 landings, accumulating 2,089t. Length frequency samples were collected from both the NS and NB side of the Bay of Fundy with means at 25.7 cm and 25.2 cm. Two boats made individual landings at Trinity Ledge catching 50t, and seven boats fished over two days in German Bank, making 11 landings, for a total of 757t. The mean length of herring seined in German Bank was determined

to be 25.7 cm. A single landing was made at Seal Island by a seiner, in turn landing 101t of herring.

Week 33: August 12- August 18

Twenty-one seiners fished for herring this week. Seven boats fished on the Long Island Shore this week, and together made 30 landings through which 787t of herring was landed. Thirteen vessels fished German Bank during the week, making 54 landings; the total tonnage of fish landed was 2,697t. The mean length of fish from German Bank was 26.6 cm this week. One boat fished in both Trinity Ledge (13t) and Gannet Dry Ledge (7t) for one night each respectively. Scot's Bay was the area where six boats made 14 landings this week, bringing in a total of 656t. Samples from the NS and NB side of the Bay of Fundy had mean length samples at 25.8 cm and 26.3 cm. On the fishing night of August 16, an industry/DFO sponsored mapping and acoustics survey of Scot's Bay was initiated.

Week 34: August 19- August 25

Twenty-one seiners fished this week. Eight boats participated in the Long Island Shore fishery this week, making a total of 27 landings (791 tonnes). A total of 13 boats fished in German Bank during the week, making 43 landings (2,634 tonnes). Length frequency samples collected from German Bank had a mean length of 28 cm. Two boats made landings in Scot's Bay in the beginning of the week (76 tonnes). Two vessels fished for one night each at Gannet Dry Ledge (216 tonnes). Samples taken on the NS side of the Bay of Fundy had a mean length of 25.2 cm.

Week 35: August 26 – September 1

Nineteen vessels fished for herring. Six seiners visited Long Island Shore this week with 19 landings (440t). One boat fished for one night at Yankee Bank (8t) and one night at Grand Manan. A total of two landings were made from Grand Manan Banks (56t). The market for fish remains the same, "not good". The Weather this week was very good. Fish size on NW Ledge was reported at 8"-10". Great quantities of fish were reported on Long Island Shore and the Ledge. The fish were staying close to land in the shoal water. No small fish sightings were reported. Fourteen boats fished on German Bank for the majority of the week, making 50 landings (3,494t). The first industry/DFO scientific survey of German Bank for 2001 was held on August 26. Samples collected from German Bank had a mean length of 28.4 cm, samples from the NS side of the Bay of Fundy had a mean length of 24.4 cm.

Week 36: September 2 – September 8

There were 19 herring seiners fishing for herring this week. Thirteen boats fished German Bank this week, making 43 landings and landing 2,618t. Markets were still low this week to the fish sizes being mixed. The fish caught on German Bank were ripe, but with small roe sacks. Length frequency samples taken from German Bank had a mean of 27.5 cm. There was plenty of fish most nights, but they were staying deep. The weather was good. No sightings of small fish were reported. Five vessels also fished Grand Manan, with 8 landings for a total of

150t. Seven boats were fishing on the Long Island Shore, bringing in 398t over 18 landings. Three vessels made one landing each on Gannet Dry Ledge, which produced a total of 193t. Samples taken from the NS side of Bay of Fundy had a mean length of 24.2 cm.

Week 37: September 9 – September 15

Twenty seiners fished for herring. Weather was good this week. Fourteen herring seiners fished German Bank over the week. The seiners collectively made 51 landings and landed a total of 2,695t. Fish were reported to be "not much good for roe" due to size. The mean fish length on German Bank was 27.1 cm.

Two scientific mapping and acoustics surveys were completed on German Bank this week. The first was held on September 9, and involved 14 purse seiners. HSC staff took a length frequency sample was taken by showing a range of 24-34cm and modes at 26 and 30cm. The fish sampled were in spawning condition and suitable for roe markets. The second survey was set up to document fish that were not noticed during the survey earlier in the week, and was held on September 13. Fish were small in size, and many boats did not have successful fishing sets.

Seven boats fished on Long Island Shore this week, making a total of 22 landings or 509t. Four boats fished on Grand Manan banks this week, making 6 landings and landing a total of 152t. Lots of non-market fish were spotted below Grand Manan. Eight boats fished the Gannet Dry Ledge this week, making a total of 11 landings (398 tonnes of herring). Fish on NW Ledge were 8"-10", with some sets at 7"-8". Samples taken from the NS and NB sides of the Bay of Fundy had mean lengths of 24.5 cm and 23.3 cm. One herring seiner was involved in an HSC/DFO survey of Trinity Ledge on September 11. However, due to technical problems with the portable data-logging unit, a paper survey could only be conducted. Fish that had been in the area earlier in the week had moved on by the time the survey was initiated.

Week 38: September 16 – September 22

Twenty herring seiners fished. Six boats fished on Grand Manan Banks, making a total of 4 landings (100t). Nine vessels fished Long Island Shore this week, with 30 landings (1,276t). One vessel made one landing on the Gannet Dry Ledge (50t). Thirteen vessels fished for herring on German Bank, making a total of 55 landings, and landing a total of 4,407t.

An HSC/DFO Tagging Program was implemented over three days this week (17,18,19) on German Bank. This involved 6 vessels over the three nights. Length frequency samples were taken each night by HSC & DFO staff. A total of 9,698 fish were tagged over the three nights (Table B-1). There have been 35 recaptures to date (Table B-2) with most fish re-caught on German Bank within five days of tagging (Figure B-1).

Samples from German Bank had mean lengths of 27.0 cm, NS side of Bay of Fundy was 23.9 cm, and NB side of Bay of Fundy at 21.6 cm. Sets were reported by Captains to contain some big fish, but most still being mixed with different sizes of fish. Fish are staying on bottom most of the time. There are "lots of fish covering a big area". The weather was excellent this week. There was no change in the markets, due to fish size. Finally, there were no reports of non-market size fish.

Week 39: September 23- September 29

Twenty vessels fished. Eleven boats fished on German Bank landing 17 times, for a total catch of 1,004t. An HSC/DFO survey of German Bank was carried out on September 25. This was a non-fishing survey, in which 6 vessels surveyed German Bank, 3 vessels surveyed Brown's Bank, and 3 vessels surveyed Spectacle Buoy area. No samples were taken, as very little fish was found to set on. 15 vessels fished the Long Island Shore this week, with 42 landings, which brought in 1,642t. One vessel fished one night on Gannet Dry Ledge to land 56t. Easterly winds were reported all week, which didn't seem to bother fish on the NW Ledge and Long Island Shore but drove fish from German Bank and Spectacle Buoy areas. Fish were still of the range 7"-10", with more 5"-6" fish showing, and having 4.5% fat. North of Moore's Ledge a Captain reported a fair area of spent fish (8"-12"). Fish showed up late in the week at Trinity Ledge, but there were reports of fish in the area for the last two weeks. The bait season had started for some vessels. There was no change in the market this week. Length frequency samples were taken in some areas: German Bank mean of 26.9 cm, and NS side of Bay of Fundy at 22.9 cm.

Week 40: September 30 – October 6

During the week, 20 herring seiners were actively fishing. 16 boats visited the Long Island Shore during the week, to land 1,672t with 40 landings from that area. 3 boats fished on banks off Grand Manan, with 10 landings and 279t in total. Seven vessels made fishing sets on German Bank this week, for a total of 16 landings and 1,594t from that area. Three boats fished in New Brunswick Coastal, making six landings, which totaled 276t. Weather this week was not very good. One sample was taken from German Bank with a mean length of 26.6 cm. Samples taken from the NS and NB side of Bay of Fundy had means at 24.7 cm and 23.1 cm.

Week 41: October 7- October 14

Twenty boats in total fished. Weather was not the best this week. HSC/DFO wanted to have a survey on German Bank this week, but most boats were not fishing for roe or not fishing in the area at all, and wanted to finish up any quota they had left. Therefore the survey was postponed until after the quota year was finished. Eleven vessels fished on Grand Manan banks making a total of 34 landings and 1,854t. Ten boats fished on the Long Island Shore, making 12 landings and bringing in 869t. Two landings were made at Gannet Dry Ledge, for a total of 71t. One set was made on the SW Grounds (66t). Samples collected

from the NB side of the Bay of Fundy had a mean length of 22.7 cm. Five boats made single sets from German Bank to land 215t. Mean length of fish caught in German Bank was 23.7 cm. Two vessels also made single sets from Lurcher, which totaled 144t. Six sets were made this week on Brown's Bank, to procure 446t. The mean length of fish sampled from Brown's Bank was 25.8 cm.

Overwintering Areas

Chebucto Head

Week 2: January 8-13, 2001
Two seiners participated in a scientific survey and tagging program off Chebucto Head this week. A total of three commercial landings were made from this area. A total of 472t was landed from Halifax this week. The mean length of herring was 24.4 cm. A total of 11,018 fish were tagged (Table B-1) with 46 recaptures to-date (Table B-2).

Week 2: January 8-10, 2002
Again, two seiners participated in surveying and tagging activities off Chebucto Head. Four landings were made over two nights. A total of 9,605 fish were tagged (Table B-1) with 41 recaptures to-date, all from the same area on subsequent fishing nights (Table B-2).

Acknowledgements

An expression of sincere thanks to Joy Fry of the Atlantic Herring Co-op and Donna Larkin of South West Seiners Co. Ltd, who provided seiner location and catch information necessary to complete this report. A very special thank you is extended to Captain Delma Doucette, whose contribution of weekly fishing activity information added tremendously to the body of this report and to the understanding of the past fishing season.

Table A-1. 2001 herring purse seine catches (t) by fishing ground and week (data from weekly Commercial Data Division updates).

CATCH_MT	Week													
Fishing Grounds	2	9	17	18	19	20	21	22	23	24	25	26	27	28
Browns Bank														
Gannet,Dry Ledge							26		638			160		
Georges Bank														121
German Bank							116	106	1,179	142		192		93
Grand Manan								664	602	583	907	727	839	593
Halifax	472													
Long Island							802	178	94	132				569
Lurcher														
N.B. Coastal														
Offshore Banks		8					3	101	159	45	2,326	1,553		
Pollock Point														
S.W. Grounds			1								19			29
Scots Bay														2,886
Seal Island														
Shelburne										233				
Trinity														
Western Hole			111	1,405	1,030	218	100			3,407	1,016		268	
Yankee Bank														
Grand Total	472	8	112	1,405	1,030	218	1,047	1,049	2,672	4,542	4,268	2,632	1,107	4,291

Sum of CATCH_MT	Week													
Fishing Grounds	29	30	31	32	33	34	35	36	37	38	39	40	41	Total
Browns Bank													446	446
Gannet,Dry Ledge	46	155	1,281		7	216		193	398	50	56		71	3,297
Georges Bank	254	143	249	183	241	80	192	352	330	206	258	212	99	2,920
German Bank			96	757	2,697	2,634	3,494	2,618	2,695	4,407	1,004	1,594	215	24,039
Grand Manan	325	554	440				56	150	152	100		279	1,854	8,825
Halifax														472
Long Island	731	144	109	849	787	791	440	398	509	1,276	1,642	1,672	869	11,992
Lurcher			224										144	368
N.B. Coastal												276		276
Offshore Banks														4,195
Pollock Point		1,689												1,689
S.W. Grounds													66	115
Scots Bay	3,460	885	733	2,089	656	76								10,785
Seal Island				101										101
Shelburne														233
Trinity				50	13									63
Western Hole														7,555
Yankee Bank							8							8
Grand Total	4,816	3,570	3,132	4,029	4,401	3,797	4,190	3,711	4,084	6,039	2,960	4,033	3,764	77,379

Table A-2. Herring purse seine mean length (mm) from length frequency sampling by NAFO unit area and week for the 2001 fishery.

MEAN_LEN	AREA												
	4Wh	4Wj	4Wk	4Xm	4Xn	4Xo	4Xp	4Xq	4Xr	4Xs	5Yb	5Yd	Overall
WEEK	455	456	457	461	462	463	464	465	466	467	511	513	Mean
1				254									254
2				244									244
17						149							149
18						160							160
19						172							172
20												285	285
21									228			281	254
22			293					251	216	213			243
23	265				296			269	236	220			257
24					290	291		278	234	229			264
25	278	287	290			274				255	258		274
26	300		303							252	249		276
27					282				270	250			267
28									262	254			258
29									259	280	246		262
30								283	263	261	248		264
31								262	266		251		260
32								257	257	252			255
33								266	258	262			262
34								280	251				266
35								284	244				264
36								275	242				258
37								271	245	233			250
38								270	239	216			242
39								269	229				249
40								266	246	231			248
41							258	237		227			241
42								236	235	226			232
43									232	220			226
44										217			217
Overall	281	287	295	249	289	209	258	266	246	239	250	283	253

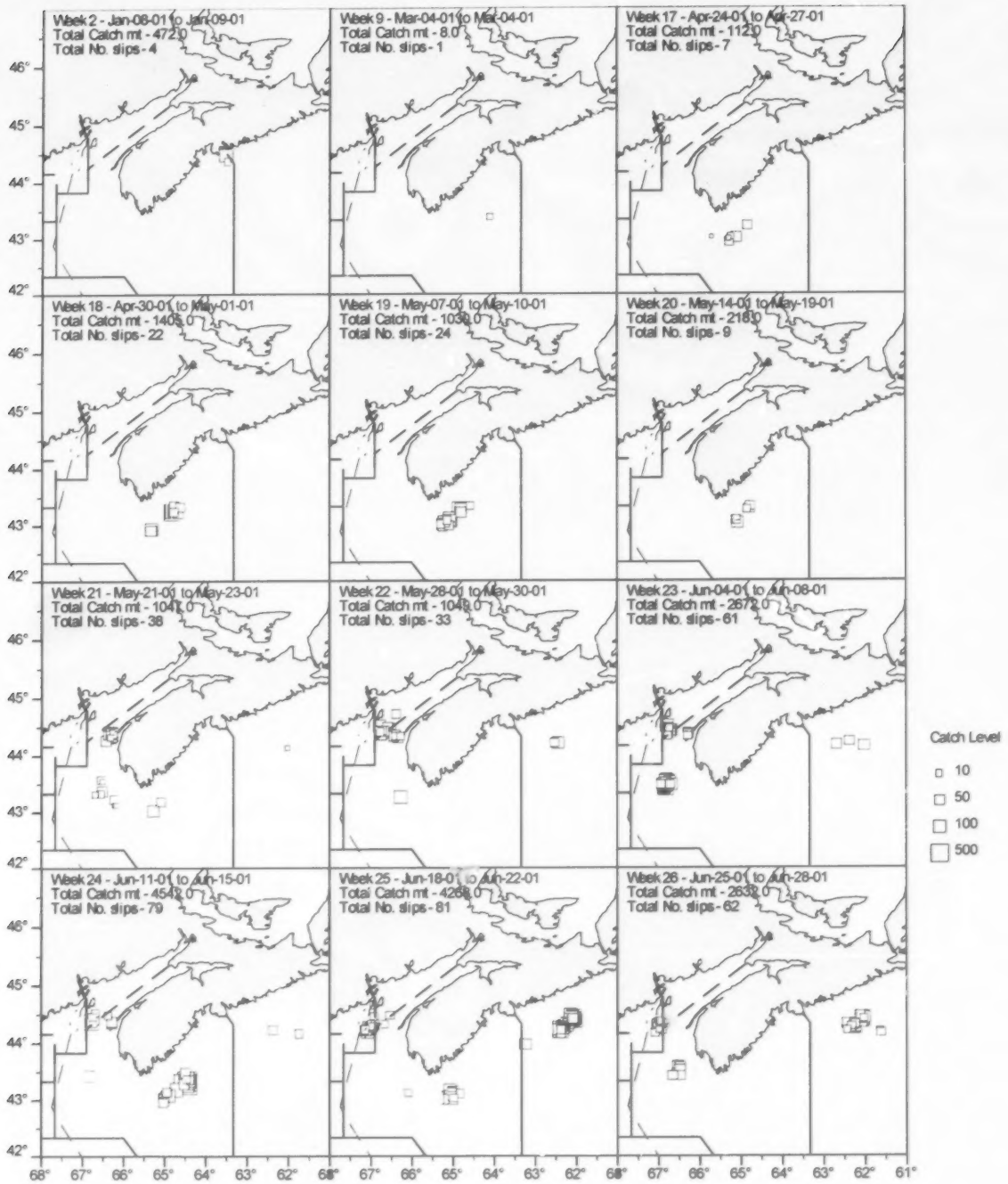

Figure A1-1. Herring purse seine and midwater trawl catches (t) for weeks 2-26 for the 2001 fishery (data from Commercial Data Division weekly updates).

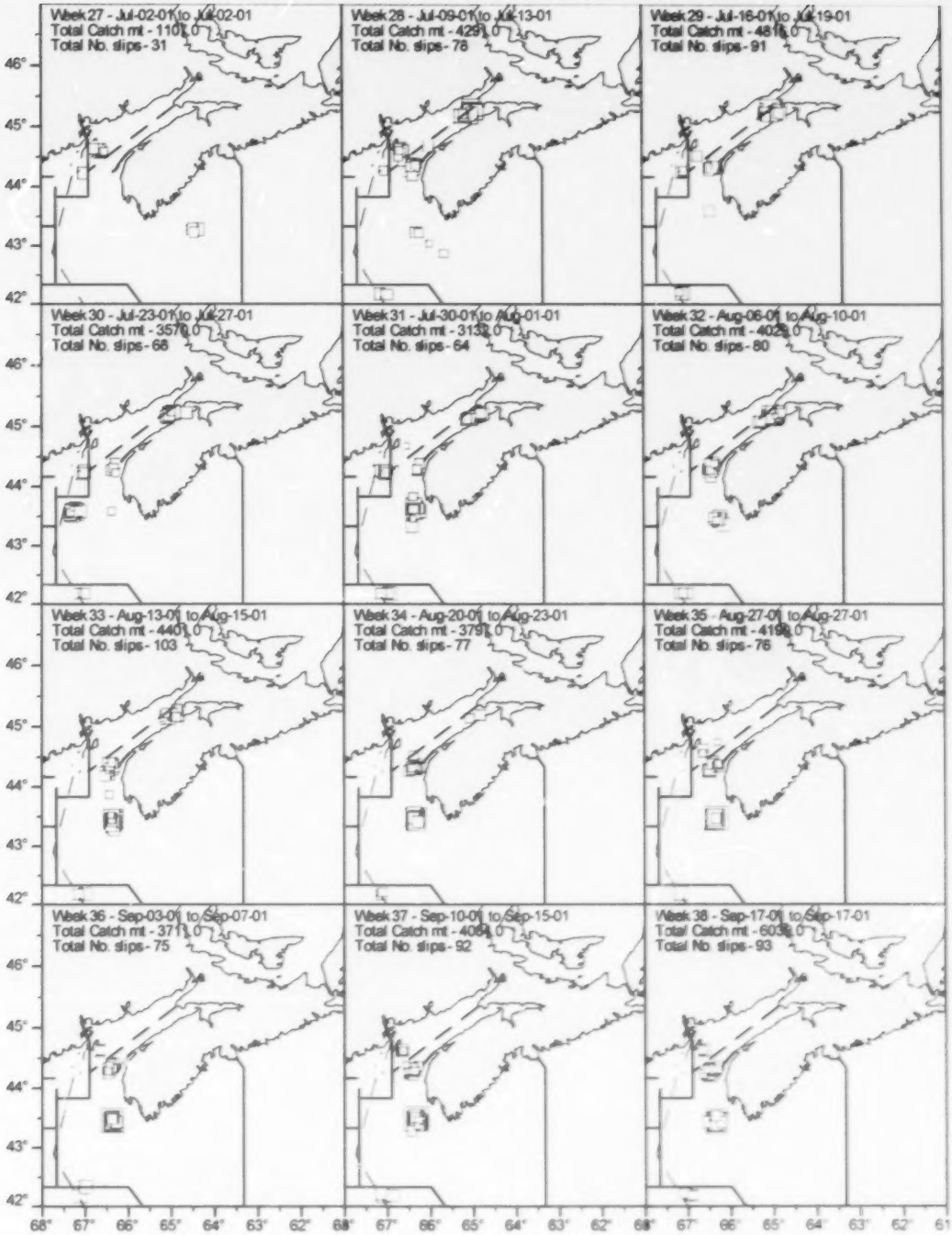
Week 27 - Jul-02-01 to Jul-02-01
Total Catch mt - 1101.0
Total No. slips - 31
Week 28 - Jul-09-01 to Jul-13-01
Total Catch mt - 4291.0
Total No. slips - 78
Week 29 - Jul-16-01 to Jul-19-01
Total Catch mt - 4818.0
Total No. slips - 91
Week 30 - Jul-23-01 to Jul-27-01
Total Catch mt - 3570.0
Total No. slips - 68
Week 31 - Jul-30-01 to Aug-01-01
Total Catch mt - 3132.0
Total No. slips - 64
Week 32 - Aug-06-01 to Aug-10-01
Total Catch mt - 4025.0
Total No. slips - 80
Week 33 - Aug-13-01 to Aug-15-01
Total Catch mt - 4401.0
Total No. slips - 103
Week 34 - Aug-20-01 to Aug-23-01
Total Catch mt - 3791.0
Total No. slips - 77
Week 35 - Aug-27-01 to Aug-27-01
Total Catch mt - 4198.0
Total No. slips - 76
Week 36 - Sep-03-01 to Sep-07-01
Total Catch mt - 3711.0
Total No. slips - 75
Week 37 - Sep-10-01 to Sep-15-01
Total Catch mt - 4084.0
Total No. slips - 92
Week 38 - Sep-17-01 to Sep-17-01
Total Catch mt - 6038.0
Total No. slips - 93
46°
45°
44°
43°
42°
68°
67°
66°
65°
64°
63°
62°
61

Figure A1-2. Herring purse seine and midwater trawl catches (t) for weeks 27-38 for the 2001 fishery (data from Commercial Data Division weekly updates).

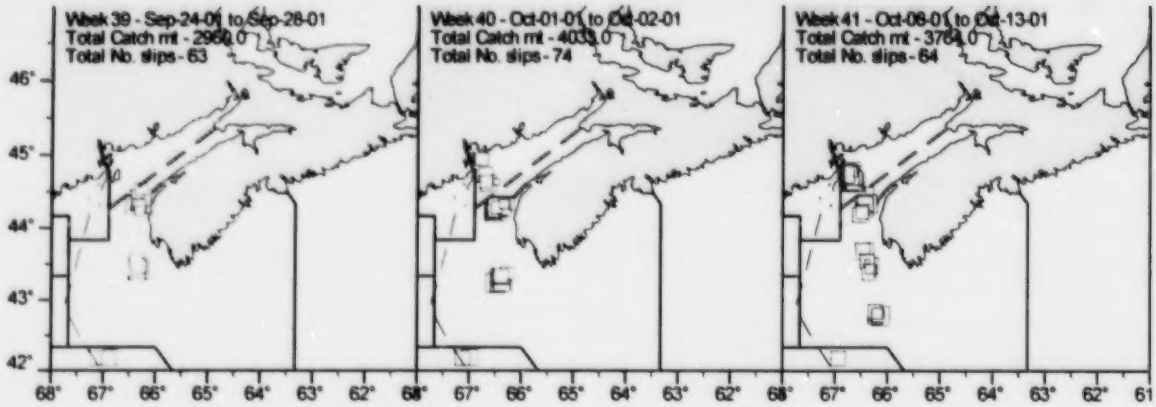
Week 39 - Sep-24-01 to Sep-28-01
Total Catch mt - 2960.0
Total No. slips - 63
Week 40 - Oct-01-01 to Oct-02-01
Total Catch mt - 4033.0
Total No. slips - 74
Week 41 - Oct-08-01 to Oct-13-01
Total Catch mt - 3764.0
Total No. slips - 64
46°
45°
44°
43°
42°
68° 67° 66° 65° 64° 63° 62°

Figure A1-3. Herring purse seine and midwater trawl catches (t) for weeks 39-41 for the 2001 fishery (data from Commercial Data Division weekly updates).

Appendix A. 2001 4WX Herring Fishery: Seiner Fleet Activity

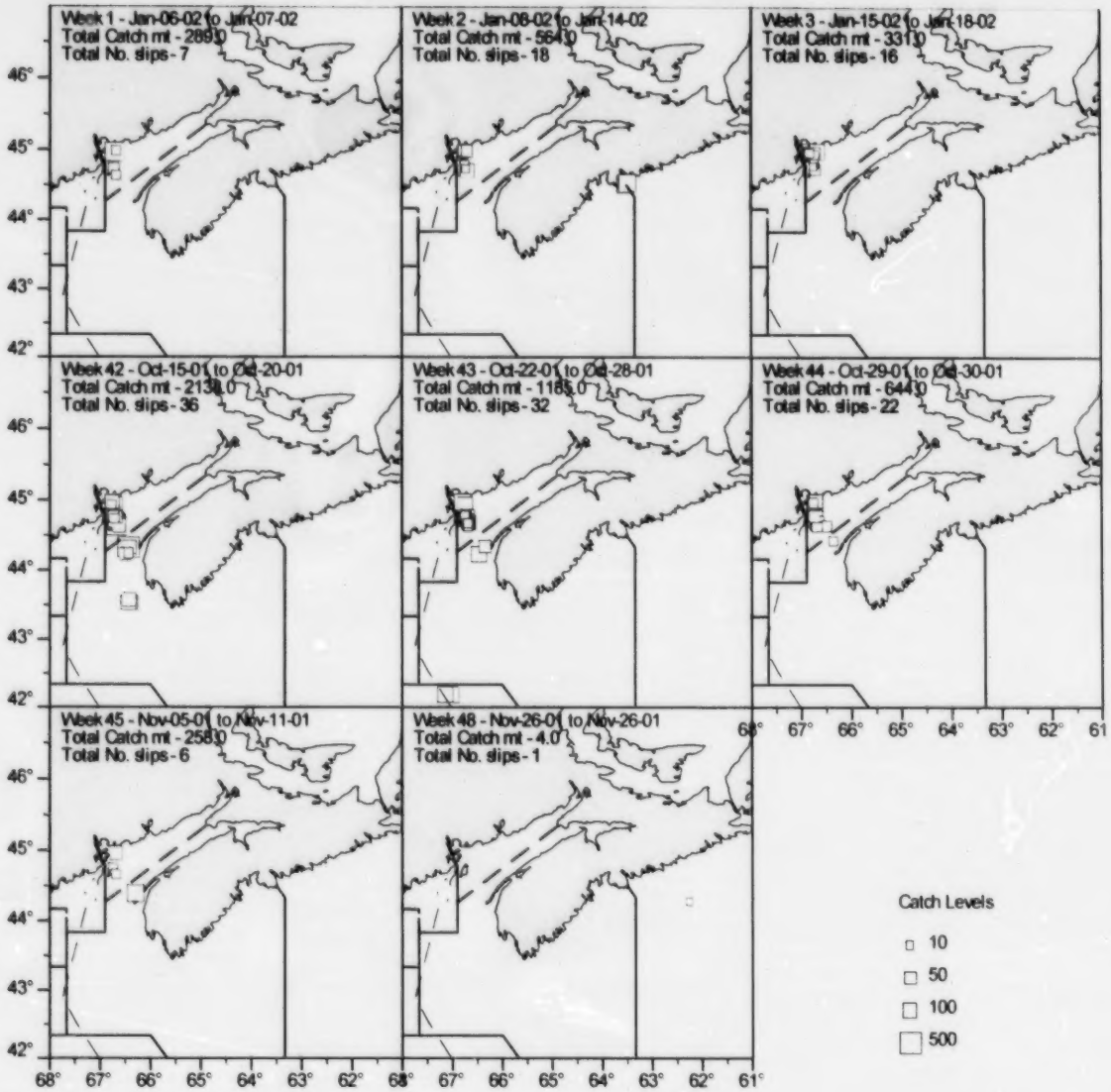

Figure A1-4. Herring purse seine and midwater trawl catches (t) for weeks 1-3 (January 2002) and weeks 42-48 (Oct/Nov 2001) for the 2001-2002 quota year fishery (data from Commercial Data Division weekly updates).

Appendix B. 2001-2002 4WX tagging summary

Table B-1. Summary of herring tagging applications (releases) by area of release and date for the 2001 to 2002 season.

Tag Release Summary 2001-02 (January)				
Location	**Year**	**Date**	**# of Tags**	**Total**
Chebucto Head	2001	04-Jan-01	3,300	
		05-Jan-01	7,718	11,018
German Bank	2001	17-Sep-01	3,461	
		18-Sep-01	1,718	
		19-Sep-01	4,519	9,698
Chebucto Head	2002	09-Jan-02	4,563	
		10-Jan-02	5,042	9,605
Total Tags Released 2001-02 (January)				***30,321***

Table B-2. Summary of herring tagging recoveries (returns) by area of release (with tags recovered within 14 days separated) for the 2001 to 2002 season.

Released from Chebucto Head, January 2001			
Days after release	**Location of Return**		**# of Tags**
0-14	Chebucto Head		3
> 14 days	Bay of Fundy		2
	Block Island Sound, RI, USA		1
	Brown's Bank		1
	German Bank		8
	Long Island Shore		5
	Moore's Ledge		1
	Northeast Bank		1
	North Head, Grand Manan		1
	Northwest Ledge		2
	The Patch		3
	Pollock Tow		1
	Roseway Bank		6
	Scot's Bay		7
	Tongue Ground		2
	Tusket Islands		1
	Western Hole		1
Total Tags Returned from Chebucto Head '01			***46***

Released from German Bank, September 2001			
Days after release	**Location of Return**		**# of Tags**
0-14	German Bank		32
>14 days	Isles of Shoals, NH, USA		1
	Mount Desert, ME, USA		1
	Stellwagen Bank, USA		1
Total Tags Returned from German Bank '01			***35***

Released from Chebucto Head, January 2002			
Days after release	**Location of Return**		**# of Tags**
0-14	Chebucto Head		41
Total Tags Returned from Chebucto Head '02			***41***

Total Returns 2001- 2002 = 122

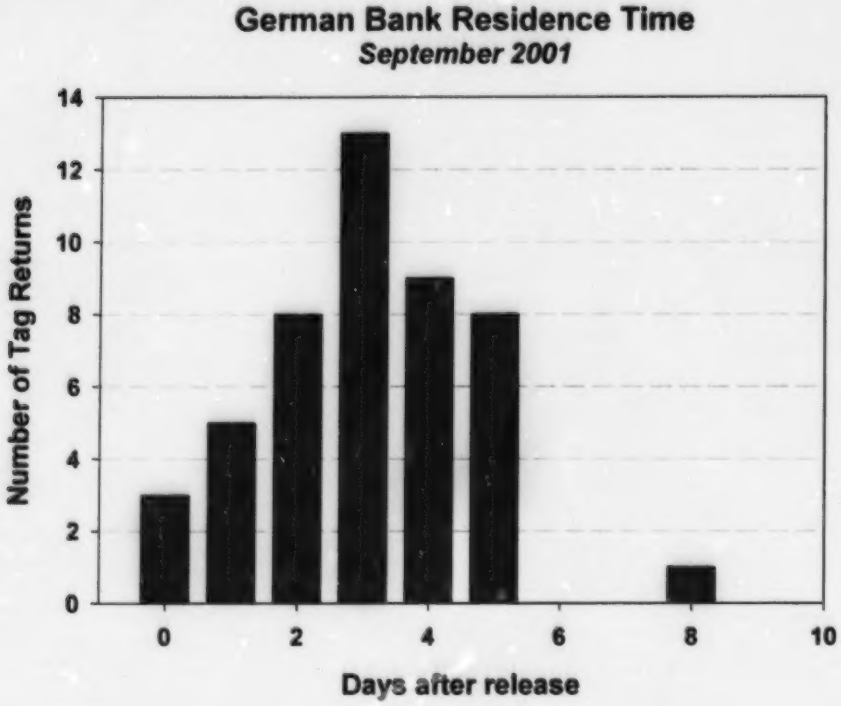

Figure B-1. Herring tag recoveries (number of tag returns by day) as an indicator of residence time on German Bank for tags applied from Sept. 17, 2001 to Sept. 19, 2001.

Appendix C.

An analysis of the turnover rates of herring on the German Bank Spawning Grounds

1. Introduction

The current assessment methods for 4VWX herring involve repeated acoustic surveys of spawning grounds (Melvin *et al*, 1999). Information about the length of time that these fish remain on the spawning grounds and whether or not they leave immediately after spawning is therefore of great importance. The amount of time that Atlantic herring spend on the spawning grounds and the factors that initiate migration and homing are not well known (Haegele and Schweigert, 1985).

Since 1997 the calculation of the spawning stock biomass (SSB) for Southwest Nova Scotia herring has been based on the acoustic estimates from regular surveys conducted on the spawning grounds. This is a change from previous years when the SSB estimate was based on a VPA tuned using a fall larval herring survey. (Stephenson *et al*, 1998). The time between surveys has therefore become a critical factor since surveys which are too close together may count the same fish.

In 1998 and 1999, surveys were separated by periods of at least 10 days so that double counting was thought to have been avoided (Stephenson *et al*, 1999; Melvin *et al*, 2000). After the discovery that some tagged herring remained on German Bank in excess of 10 days, this separation period was widened to approximately two weeks in 2000 (Paul, 1999; Melvin *et al*, 2001) and 2001. However, the opinion was expressed by the fishing industry that turnover time is variable and that entire waves of spawning fish may be missed or discounted if two weeks are left between surveys. It was therefore recommended that additional research effort be put into investigating the turnover time of herring on the spawning grounds (Melvin *et al*, 2001). This report represents the beginning of a more intensive evaluation of turnover rates in Southwest Nova Scotia. Since German Bank currently supports the largest spawning component in the 4WX stock complex it was chosen as the initial site for study.

2. Methods

Since 1996, industry partners, including fish plants and fishers' organizations, have provided length frequency samples according to Science specifications (Stephenson *et al*, 1997). This enhanced level of sampling has been very beneficial to the evaluation of stock status. In spite of this intensive spawning sampling, however, there are still gaps, particularly in the number of detailed samples which provide information on sex, age and maturity and this has made it difficult to examine certain key biological questions such as the rate of turnover.

Appendix C.

In 2001, a program of daily sampling of herring from the German Bank spawning ground was set up with the assistance of Scotia Garden Seafood Inc. fish processing plant. Between September 4th and 25th, fifteen samples of about 200 fish were randomly collected directly from the landing vessel before any sorting for size or sex had been done (Table C1). These fish were frozen in blocks and saved for analysis at St. Andrews Biological Station. Each Scotia Garden Seafood Inc. sample was first measured for length and the fish were stratified for age analysis (two per half centimetre). The stratified sample, plus additional fish to increase the sample to 100 individuals, was measured for length, weight, sex, maturity and gonad weight. All data were entered directly into an Oracle database. Scotia Garden Seafood Inc. also provided fat content for fish fillets and this information was included in the analysis.

For the purposes of analysis of length, age and maturity data, the information collected from the Scotia Garden special samples was combined with data collected from German Bank through the regular sampling program. These data were stored on the same Oracle database.

3. Results

3.1 Historical Analysis

Length and maturity data were extracted for the years 1995 to 2001 for the German Bank spawning grounds. Average length frequencies and percent of spawning (stage 6) herring by year and calendar date are shown in Figure C1. Although there are frequent gaps, particularly in the maturity data, which make it difficult to reach any firm conclusions, variations in mean length and percent of spawning herring are certainly evident and may reflect the fact that one group of herring has left and been replaced by a new group.

3.2 Data Collection in 2001

3.2.1 Tagging

In 2001, intensive tagging occurred on German Bank over a three day period from September 17th to 19th. A total of 9,698 spawning (stage 6) herring were tagged. Of these, 47 tagged fish were caught and returned from the German Bank spawning grounds shortly after they were tagged. Forty six fish were caught less than seven days after tagging and one fish was caught eight days after tagging. It is noted, however, that there was a considerable decrease in the number of landings in the second week after tag application, from 55 in the first week to 17 in the second week, indicating a decrease in fishing effort. The results from the 2001 tag returns are in contrast with the findings of Paul (1999). She reported that in 1998, out of twenty eight herring tagged and returned on German Bank that same

year, seven fish were caught more than ten days and five were caught more than fourteen days after tagging (Paul, 1999).

The interpretation of this type of tagging data is difficult because it is confounded by changes in effort. If tags were applied at weekly intervals, instead of in a single application, it might be possible to use the data more effectively for examining turnover rate. If fish tagged in week 1 are not caught on the spawning ground more than seven days after the first tagging event, but fish tagged the following week are being caught and returned, then there would be a stronger basis for concluding that the fish from week 1 had left the spawning ground.

3.2.2 2001 Length Frequency and Detailed Samples

The geographic distribution of all samples analysed for length and maturity data on German Bank is shown in Figure C2. The average length and percent spawning (stage 6) herring collected from German Bank are shown in Figures C3 and C4. Changes in average length are noted between August 17th and 18th, August 22nd and 23rd, August 28th and 29th, September 5th and 6th, September 9th and 12th, and September 15th and 17th (Figure 3). Although standard errors were calculated for average lengths they are very small due to the large number of fish sampled.

The percent of spawning herring in individual samples is plotted in Figure C4. Particularly during September when many detailed samples were provided, there was considerable variation between the percents of spawning fish in individual samples. On September 17, for example, the percentage of spawning fish in four samples ranged from 8 to 91%, which is exceeds any apparent trends observed in this data series.

The daily length frequencies are shown in Figure C5. The length frequency of samples collected from German Bank tends to be bimodal but clear differences are apparent. The presence of the dominant 1998 year-class (age 3) might obscure possible trends.

A gonadosomatic index was calculated for the fifteen Scotia Garden detailed samples to see if any variation was detectable. No significant trend was found.

3.2.3 Fat Content

The fat percentages provided by Scotia Garden Seafood are shown in Figure C6. There is considerable variation between samples and no overall trend is apparent. A more comprehensive collection of fat content information might be useful in conjunction with other biological information such as lengths and maturities.

3.2.4 Age

Since there is evidence that older herring may spawn earlier in the spawning season, the age data were also examined. As anticipated the strong 1998 year-class (age 3) dominated. The percent of age 3 herring was lower at the beginning of the spawning season (August 21st) and, with a lot of variation, tended to increase slightly over time (Figure C7).

4. Conclusions

The larger number of detailed samples collected in 2001 with the assistance of Scotia Garden Seafood Inc., provide a good initial baseline for comparison with data from future years. However, the fact that the sampling period is less than the entire spawning season and the existence of gaps do cause problems for analysis.

Several approaches could be taken to help further elucidate the issue of turnover rate on the spawning grounds. Suggestions include:

1. More intensive sampling. Sampling at the intensive level conducted in 2001 should be continued in 2002 for German Bank and possibly also Scots Bay. These samples need to be collected over a longer time period (mid August to mid October) and care should be taken to avoid gaps over weekends as much as is possible. This suggestion requires the cooperation of industry and the availability of staff for processing and aging the detailed samples.

2. If tagging is to be used as a method of examining turnover rate, the application of tags at a specific interval (weekly) should be instigated on German Bank.

3. Increased acoustic effort to document the behaviour, number and size of schools of herring on the spawning grounds.

4. Documentation of herring spawning behaviour using underwater video equipment.

5. Further analysis of the historical database. Data from other spawning areas should be examined and the duration of the spawning season in relation to the age composition of the population should be examined.

References

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Appendix C.

Melvin, G.D., M.J. Power, F.J. Fife, K.J. Clark and R.L. Stephenson. 2001. Summary of 2000 herring acoustic surveys in NAFO Divisions 4WX. DFO Canadian Stock Assessment Secretariat Res. Doc. 2001/056: 41p.

Melvin, G.D., T. Scheidl, F.J. Fife, M.J. Power, K.J. Clark and R.L. Stephenson. 1999. Evaluation of the 1998 4WX herring acoustic surveys. 1999. DFO Canadian Stock Assessment Secretariat Res. Doc. 99/180: 32p.

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Stephenson, R.L., M.J. Power, K.J. Clark, G.D. Melvin, F.J. Fife, S.D. Paul, L.E. Harris and S. Boates. 1999. 1999 Evaluation of 4VWX herring. DFO Canadian Stock Assessment Secretariat Res. Doc. 99/64: 85p.

Appendix C.

Sample No.	Date	Latitude (°N)	Longitude (°W)
20011477	Sept. 10	43° 29'	66° 20'
20011478	Sept. 11	43° 29'	66° 20'
20011479	Sept. 12	43° 29'	66° 20'
20011488	Sept. 13	43° 30'	66° 20'
20011480	Sept. 14	43° 27'	66° 17'
20011481	Sept. 15	43° 25'	66° 17'
20011482	Sept. 17	43° 27'	66° 20'
20011483	Sept. 18	43° 27'	66° 20'
20011489	Sept. 19	43° 26'	66° 20'
20011484	Sept. 20	43° 24'	66° 20'
20011485	Sept. 21	43° 24'	66° 20'
20011486	Sept. 24	43° 24'	66° 21'
20011487	Sept. 25	43° 24'	66° 20'
20011475	Sept. 5	43° 27'	66° 20'
20011476	Sept. 6	43° 28'	66° 20'

Table C-1: Date and location of the fifteen special samples collected from the German Bank Fishery by Scotia Garden Seafood Inc..

Appendix C.

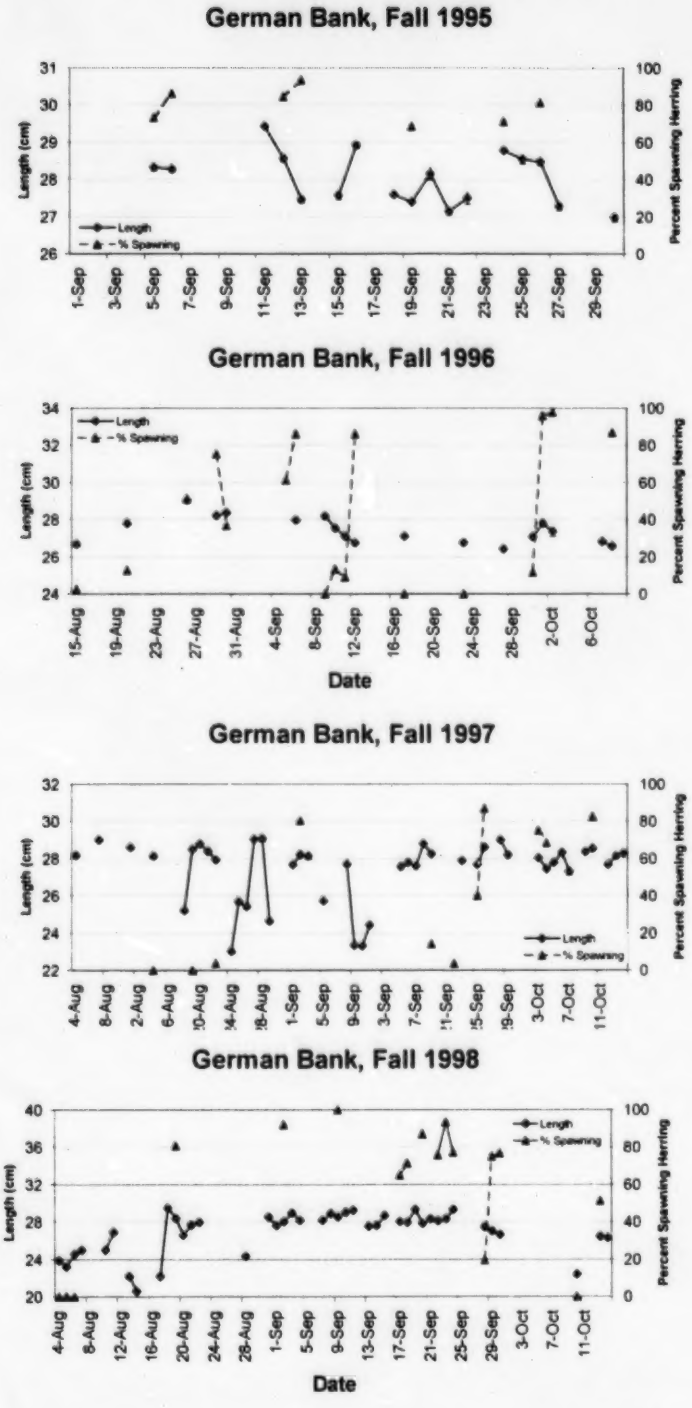

Figure C-1. Length frequency and maturity data for samples collected from German Bank, 1995 to 2000.

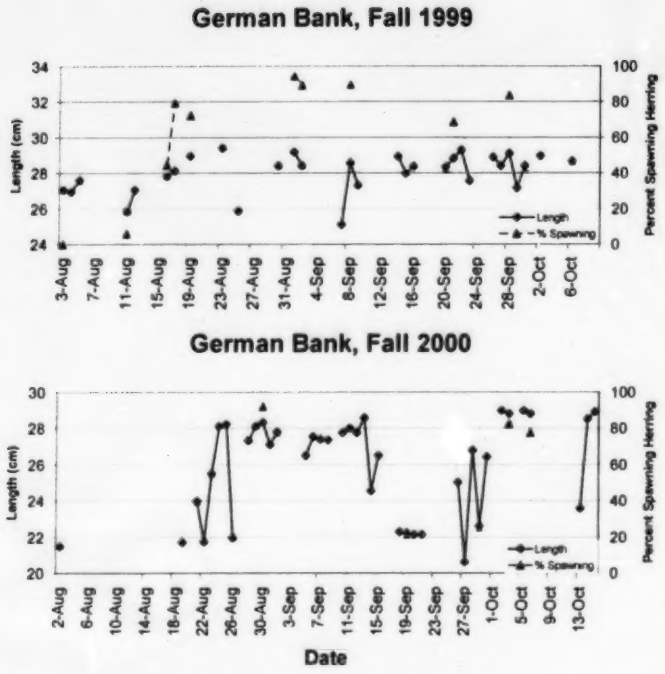

Figure C-1 (continued) Length frequency and maturity data for samples collected from German Bank, 1995 to 2000.

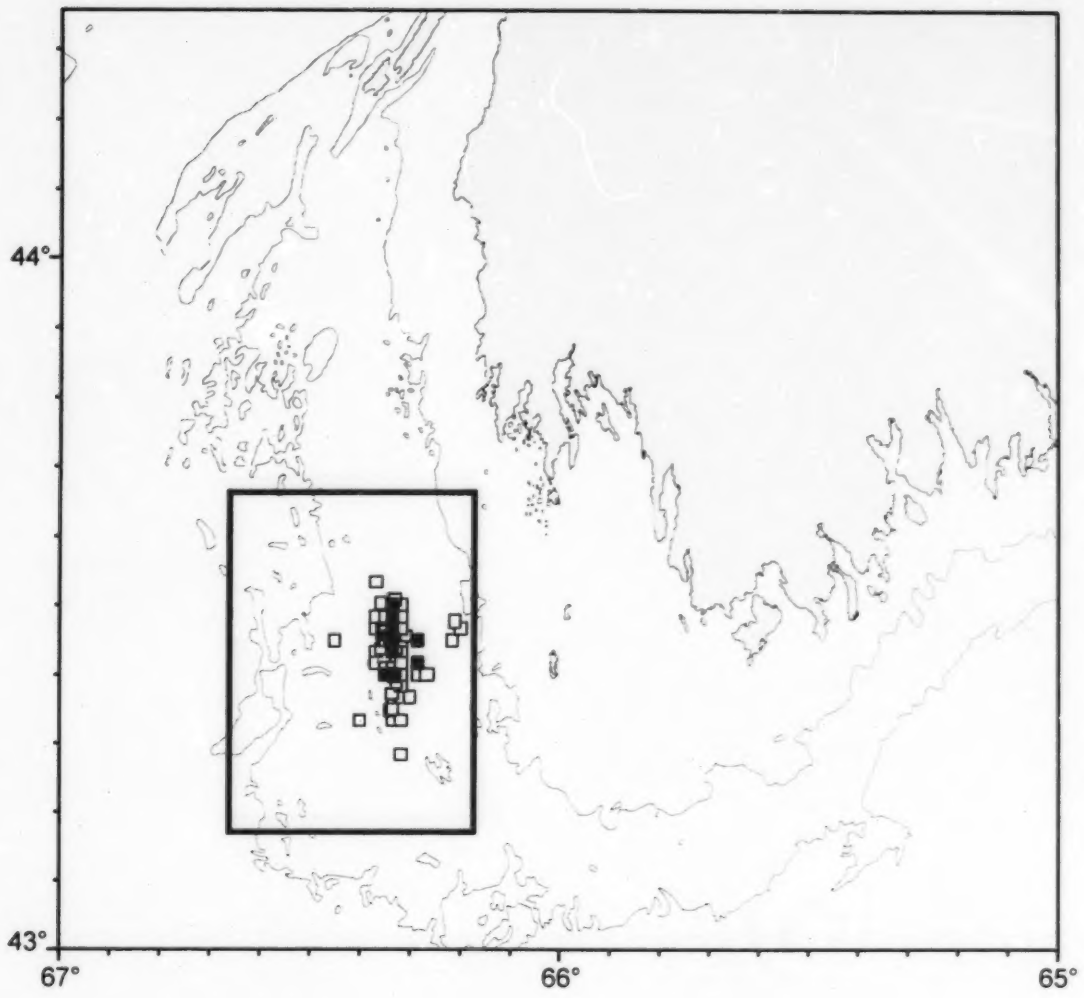

Figure C-2. Geographic location of samples from German Bank taken in 2001. Open squares represent the locations of samples taken as part of the regular sampling program. Closed squares represent the locations of the fifteen special samples taken by Scotia Garden Seafood Inc. during the month of September.

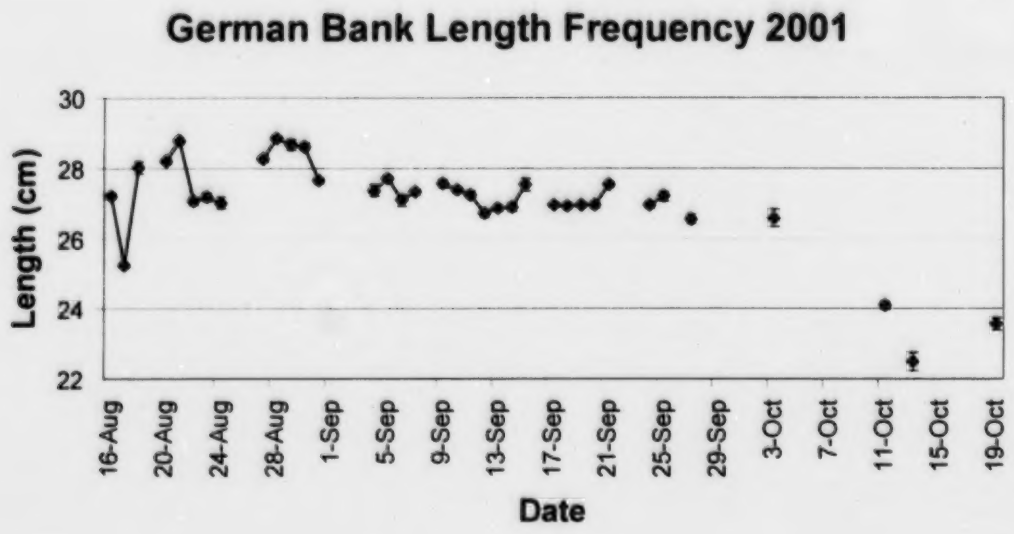

Figure C3. Average length of fish from samples collected from German Bank in 2001.

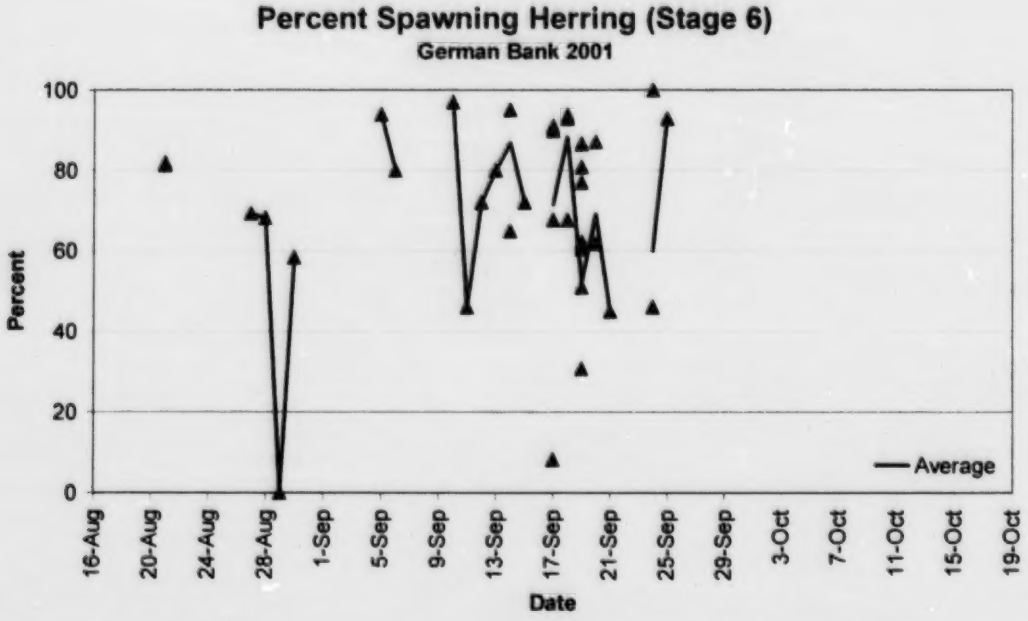

Figure C4. Percent of spawning herring in detailed samples collected from German Bank in 2001.

Appendix C.

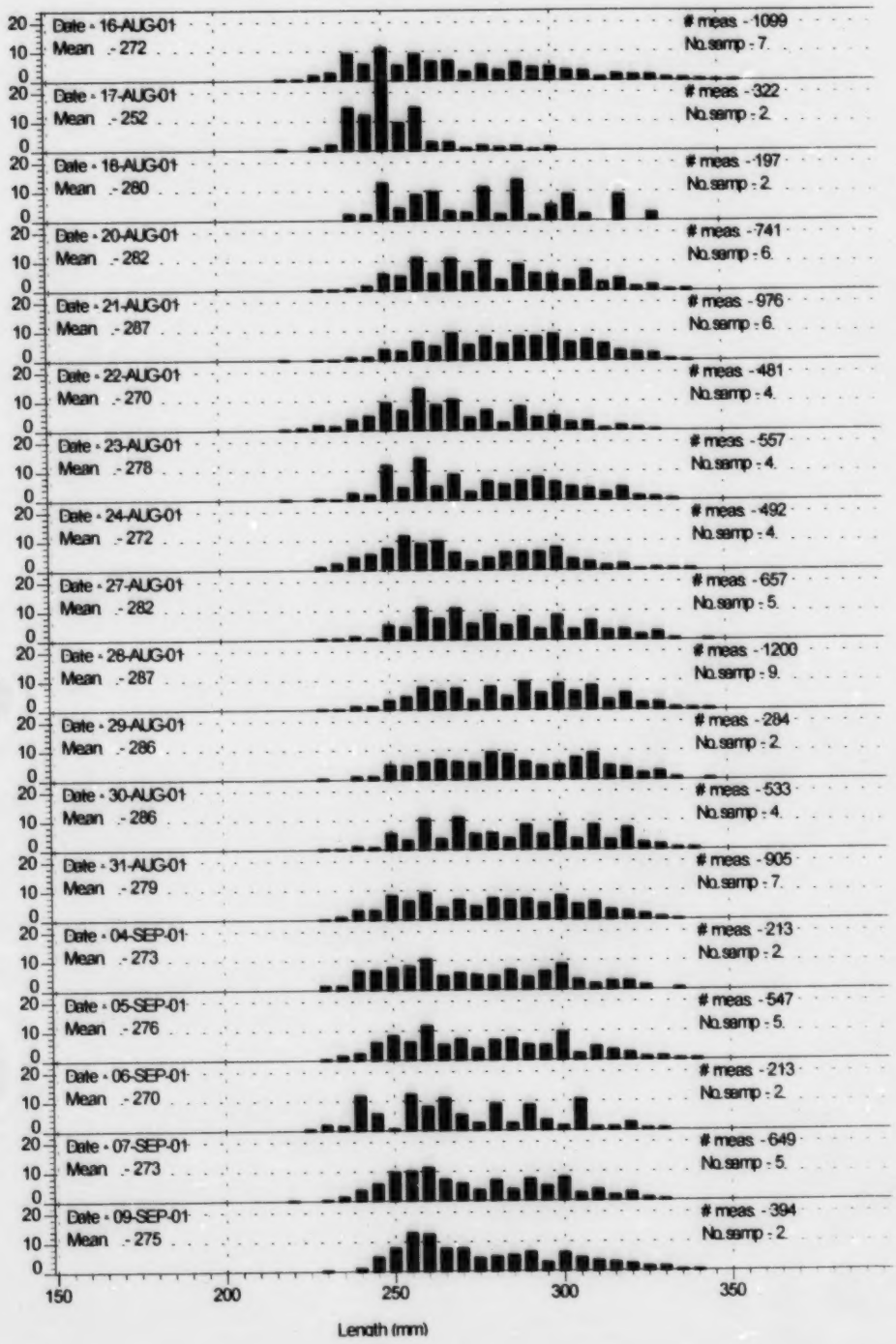

Figure C-5. Length frequencies by day of samples collected from German Bank in 2001 (Aug. 16 to Sept. 9).

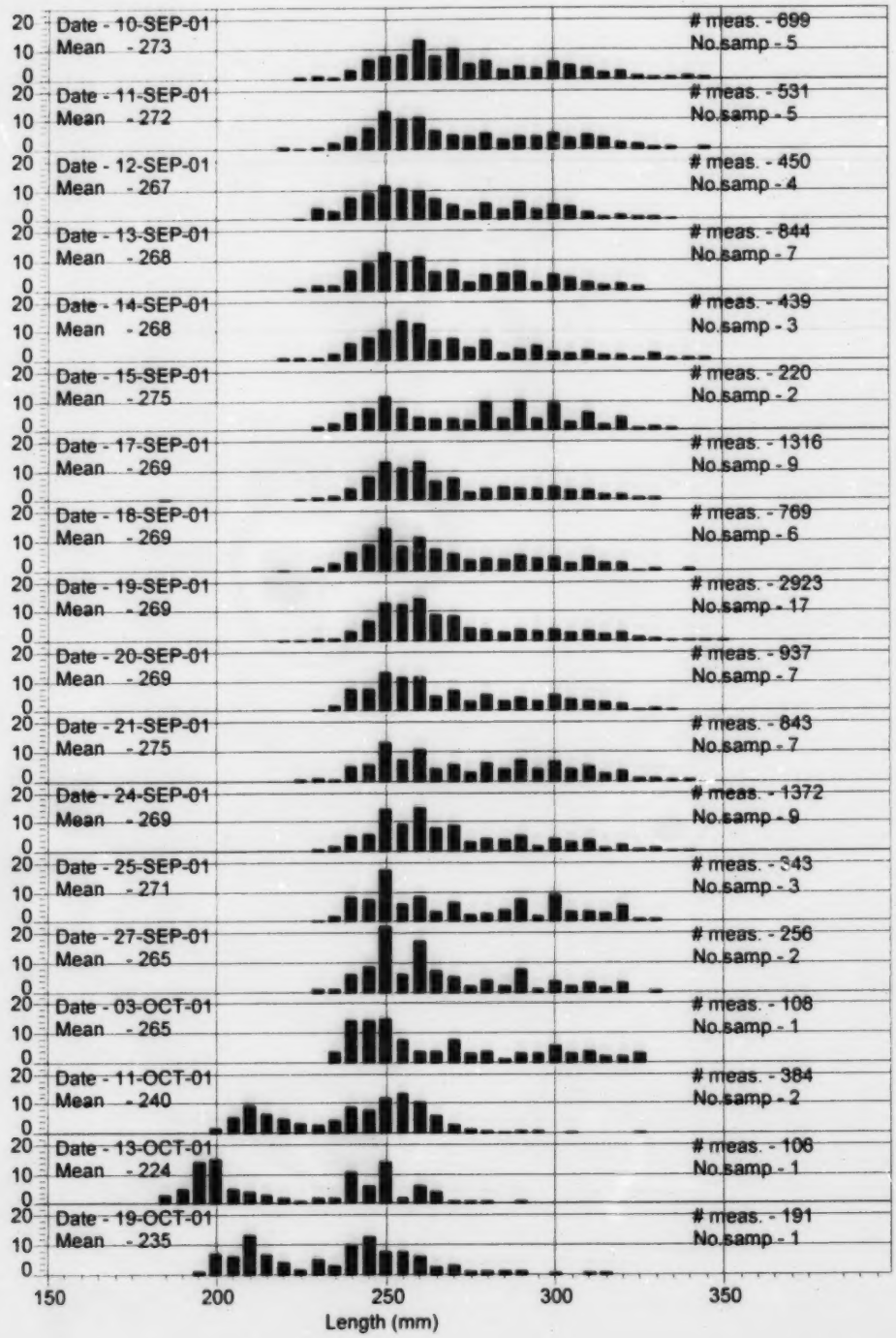

Figure C-5 (continued). Length frequencies by day of samples collected from German Bank n 2001 (Sept. 10 to Oct. 19).

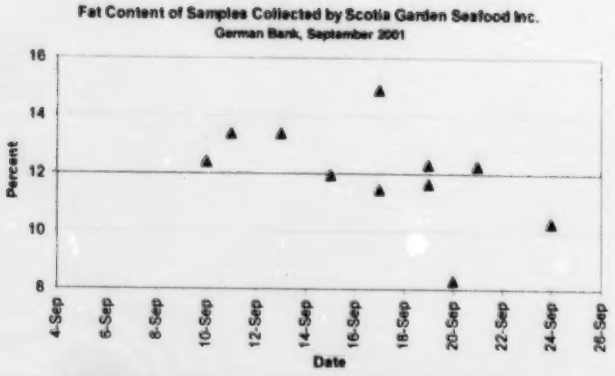

Figure C-6. Percent fat content for herring collected at the same time as the samples provided to DFO Science (data from Scotia Gardens Seafood Inc.)

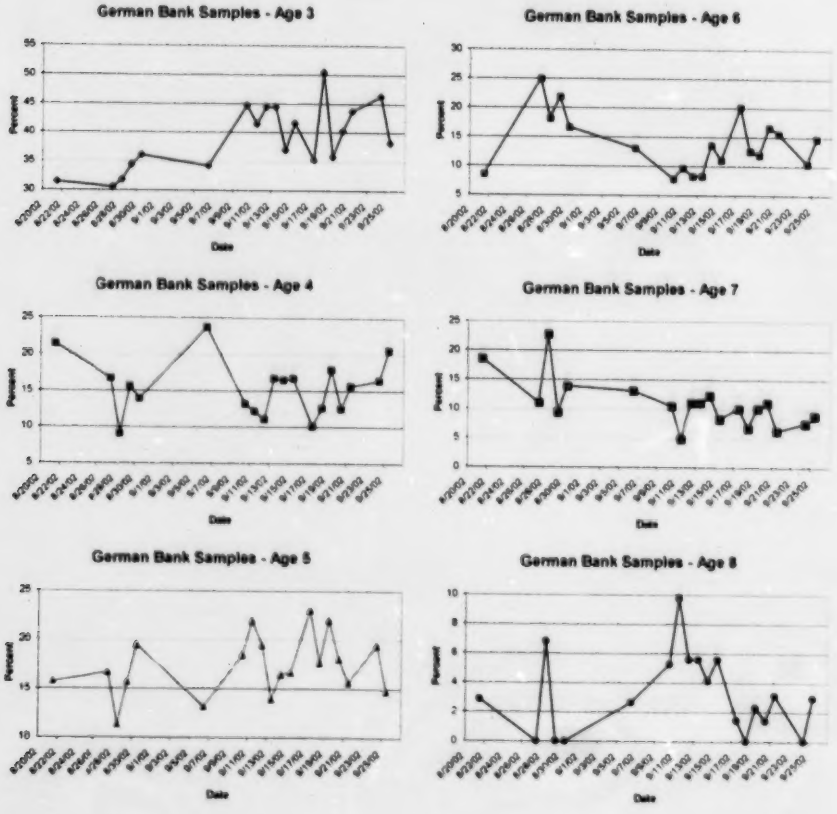
German Bank Samples - Age 3
German Bank Samples - Age 6
German Bank Samples - Age 4
German Bank Samples - Age 7
German Bank Samples - Age 5
German Bank Samples - Age 8
Percent
Date

Figure C-7. Percent numbers at age sampled for German Bank spawning samples by date.